Interactive recipe instructions: supporting cooks with better designs

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Abstract

In the last decade in HCI there has been a growing interest in using interactive technology to support human-food activities such as meal planning, shopping and cooking. However, despite the principles of UCD, few researchers have made use of empirical research of users' human-food activities to ground their system designs, few evaluated their systems with users against a control and most have designed systems with the needs of younger people in mind.

In the first two studies I investigated the food related activities of older adults using focus groups and a food and shopping diary with post diary interview. I found that older adults' food related activities were both routinized and flexible. They were knowledgeable about food, how to plan meals, shop and prepare food and did not have need for technological support. The design assumptions of early food-related systems do not generalise to older adults.

In the second two studies I investigated how cooks interact with recipe instructions in order to inform the design of interactive recipe systems. In the first cooking study I investigated the effect (1) of shorter recipe steps and (2) of integrating the instructions and information normally located in the ingredient list into the text of recipe steps. I found that cooks do not read or perform the tasks of recipe instructions in sequence. In part this is because of the nature of recipe procedures and in part because they read ahead to understand the narrative of ingredients to help them interpret the current step. Cooks found instructions with ingredient information integrated clearer and easier to read because integrating the information reduces the need for the cook to look up and mentally integrate information from different sources.

In the second cooking study I investigated the effects (1) of adding pictures to recipe steps and (2) of presenting an overview of the structure of the recipe procedure. I found that cooks liked pictures with the recipe steps but they did not reduce problems or errors. Cooks preferred recipes with a structural overview because it enabled them to understand the process and to plan and perform tasks in parallel. Results suggest that the overview presentation, by highlighting the sub-goals of recipe instructions, reduced problems due to recipe content experienced by cooks. The implications for design show that future interactive recipe systems should integrate ingredient information into the recipe steps, support cooks to move around the recipe steps non-sequentially, support cooks to perform more than one step in parallel and provide an overview of the procedure with sub-goals.

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Author's Declaration

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

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Chapter 1 Introduction

This thesis will present a programme of research that investigates the cooking and other food related activities of older adults and their potential need for technical support, if and how earlier research into systems that support human-food activities generalise to older adults and how people interact with recipe instructions in order to inform the design of future interactive recipe systems.

1.1 Background to the research

Food - what we eat and don't eat, where we buy it and how we cook and eat it - shapes who we are individually, socially, and culturally (Belasco, 2008). Within Human-Computer Interaction (HCI) there has been a growing interest in how interactive systems may benefit people - cooks in particular - and interactive systems have been proposed across all these levels. At the individual level are proposals to help people make healthier food choices (for example van Pinxteren, Geleijnse, & Kamsteeg, 2011) or developing smart kitchens to help them cook (for example Bonanni, Lee, & Selker, 2005; Kientz et al., 2008); at the social level are proposals developing ways to share meals remotely (for example Grevet, Tang, & Mynatt, 2012) or recipes among friends (for example Palay & Newman, 2009); and at the cultural level researchers are investigating how interactive interventions can influence urban culture (Choi, Foth, & Hearn, 2013). The importance of human-food interactions and the role that HCI can play in this domain have been recognised with recent workshops at CHI'12 Conference on Human-Factors in Computer Systems (CHI, 2012) and DIS'12 Conference on Designing Interactive Systems (DIS, 2012) leading to a Special Issue of International Journal of Human Computer Interaction (IJHCI) (2014, in press).

Interface design is a core topic in HCI and the role of researchers is to provide evidence to inform the design of effective interfaces (Gray & Salzman, 1998). In the commercial world there are a growing number of recipe applications, e.g. BBC Good Food[1], that provide interactive recipes systems to cooks in their kitchen. In HCI, the concept of interactive recipe systems has been explored but, as I shall lay out below, there has been little evidence, drawn from either theory or evaluation, to show what constitutes an effective design for delivering recipe instructions interactively. Providing this evidence would benefit cooks, both novice and experienced, empowering them to use the common currency of cooking knowledge and so provide personal as well as social benefits (Simmons & Chapman, 2012). Evidence would also benefit practitioners who want to design interactive systems for recipes and other forms of instructions for complex tasks.

Cooking is "one of the most interesting and worthwhile things we humans do" (Pollan, 2013, p. 11). It connects the natural world and the social world. In "providing sustenance for others with the labor of one's own hands" (Albala & Nafziger, 2010, p. ix), cooking brings great pleasure and satisfaction to those who share the meal. Cooking cannot be abstracted from the person who cooks food so it follows that it is not possible to abstract the person from discussions about cooking. As such parts of this thesis will be written in the first person to reflect my own responses to the literature and results presented therein.

Cooking is not just personal, it also has a wider political implication - it "transforms us, too, from mere consumers into producers" (Pollan, 2013, p. 21). A walk around any UK supermarket will show that we are a nation of food consumers. We buy a lot of ready-prepared meals and this is a growing concern to health and social campaigners for two reasons. Firstly, we have become reliant on the food industry to prepare food for us and their first interest is their profits and not our health (Pollan, 2013). Secondly, in our growing reliance on buying pre-prepared foods, we are at risk of losing our food knowledge and cooking skills (Caraher, Dixon, Lang, & Carr-Hill, 1999). In the UK in particular, with the introduction of the National Curriculum and

[1] http://www.bbcgoodfood.com/good-food-mobile-apps

subsequent dropping of mandatory cooking classes at schools, concerns have grown that future generations will not be able to cook and will be dependent on pre-prepared and processed foods (Caraher et al., 1999; Stitt, 1996). Similar concerns have been raised in Ireland (Iomaire & Lydon, 2011), Australia (Begley & Gallegos, 2010) and Canada (Engler-Stringer, 2010).

Encouraging home cooking with simple, straightforward recipes could be part of the solution because it wrestles control back from the food industry to those who eat the food (Simmons & Chapman, 2012). However anecdotal evidence suggests that people lack nutritional and cooking knowledge and have problems following recipes (Stead et al., 2004). As technologists interested in improving peoples' lives, this skills and knowledge gap creates a potential design space for interactive technology. For example, by providing nutritional labels (Bedi, Ruvalcaba, Fisher, Kamal, & Tsao, 2010) or using social tagging of foods (Linehan et al., 2010) to help people make healthier food choices; or by developing a nutritionally aware kitchen (Chen, Chi, Chu, Chen, & Huang, 2010) that makes salient the nutritional balance of a meal as it is being made. For novice cooks, interactive recipe systems such as *CounterActive* (Ju, Hurwitz, Judd, & Lee, 2001) that deliver recipe instructions step-by-step and provide pictures and videos alongside the words have been proposed to make cooking exciting and recipes easy to follow.

Central to any conversation about food and cooking, and central to the design of any system to support work around food and cooking is the recipe. Recipes are almost ubiquitous in modern life, appearing in magazines, cooking shows and food packaging. And being ubiquitous and commonplace, we perhaps overlook their multifaceted nature beyond the surface as a set of instructions to make a dish.

Cultural historians have recently focused on recipes as a form of cultural writing (e.g. Brownlie, Hewer, & Horne, 2005; Floyd & Forster, 2010). They have found recipes to be a rich body of material for research from which to investigate the formation of cuisines (Appadurai, 1988), the cohesiveness of communities (Bower, 1997; Cotter, 1992) and changing gender relations to food and cooking (Inness, 2005; Neuhaus, 2003). The social nature of recipes should also be considered. Recipes, as well as the dishes they describe, evoke nostalgia for times past (Supski, 2005) and serve as tokens to exchange and develop present friendships (Leonardi, 1989; McKie & Wood, 1992). The meaning of family recipes in particular, serves to shape identity through nuances of traditional dishes (Long, 2001).

Linguistic analyses of recipes found that recipes vary in structure and precision according to their intended audience (Cotter, 1992) and across time (Warde, 1994). Warde found that, over a 25 year period, recipes were not only changing in terms of sophistication with foods and techniques, they were also becoming more precise in their instructions and nutritional information. This trend is critiqued as the tyranny of the "perfect recipe" Finn (2011) who argues that striving for perfection introduces authority to the kitchen. But that tyranny only exists if the cook submits. Something that Wharton (2010) suspects rarely happens when he argues that recipes are in fact failures as procedural instructions because cooks do not read recipes to make dishes from them. The problem for the interaction design is that we do not know what cooks actually do with recipes.

Despite the wide range of research that investigates recipes and their roles in our lives, no research, to my knowledge, describes what cooks do with recipes in the kitchen. Along with the plethora of recipe blogs, there are a number of works providing best-practice advice on how to write recipes (for example Gibbs Ostmann & Baker, 2001; Jacob, 2010) but these are more focused on how to format recipes to get them published than on evidence of what works for cooks. As a consequence there it little literature about cooks' behaviours from which to draw insight into how to design interactive recipe systems.

Over the last decade, technologists have proposed a number of interactive systems for the kitchen. *CounterActive* (Ju et al., 2001) used videos and recipe steps projected onto the kitchen work surface so that cooks did not feel they were using a computer while they cooked. The concept was later developed into an *Attentive Kitchen* (Bonanni et al., 2005) in which recipe instructions were projected where the cook would most likely be looking. This concept of positioning instructions at the cook's physical location was implemented in a different way in the *Kitchen of the Future* (Siio, Hamada, & Mima, 2007) and in *PersonalChef* (Mennicken, Karrer, Russell, & Borchers, 2010), with both systems using multiple computer screens around the kitchen. Considering how cooks move about a kitchen, a novel approach was taken in the design of *EyeCook* (Shell, Bradbury, Knowles, Dickie, & Vertegaal, 2003). By using an eyetracker, *EyeCook* determined how close the cook was to the display and altered the size of the text and the amount of recipe shown accordingly.

The systems described above varied not only in their implementation but also in their focus. Whereas *CounterActive* (Ju et al., 2001) and *PersonalChef* (Mennicken et al., 2010) focused on improving the cook's confidence and enjoyment while cooking, the goal of the *HappyCooking* (Hamada et al., 2005) system implemented in the *Kitchen of the Future* (Siio et al, 2007) was to maximise efficiency and time taken to prepare multiple dishes. A different problem was addressed by the system *CooksCollage* (Tran, Calcaterra, & Mynatt, 2005). Although not an interactive recipe system itself, *CooksCollage* aimed to help cooks overcome interruptions that caused them to forget their place when they were following recipes. In their review of interactive kitchen technologies, Grimes & Harper (2008) argued that the goals of improving confidence, maximising efficiency and solving problems of distraction took a negative approach to the human experience in the kitchen. While they do not deny that such difficulties may be experienced by some cooks, Grimes and Harper argued that a more fruitful design space to explore would be one to celebrate positive experiences around food and cooking. According to Grimes and Harper, *LivingCookbook* (Terrenghi, Hilliges, & Butz, 2007) is an exemplar system that video records a cook (or a pair of cooks) preparing a dish so the video can be played back, including all the jokes and friendly banter, to friends to allow them to create the same dish in real time.

1.2 Motivation for the research

In reviewing the human-food interaction literature three things became clear; firstly the systems have almost all been designed with younger people in mind and little work has considered the needs of the wider population; secondly the problems being addressed by the systems were based on assumptions of problems that cooks experienced with little empirical evidence in support and thirdly few researchers provided comparative evaluations from which conclusions could be drawn. The first and second points provided the motivation for the first part of this programme of research which investigated older adults' food related activities. The second and third points, which are expanded below, motivated the second and main part of the research which investigated how cooks interact with recipe instructions.

Cooking and other food related activities are life skills that remain valuable all through life but to date the focus of food related HCI has been on the needs of younger adults. In contrast, at University of York we have a research interest in expanding HCI research to include older adults and people with disabilities to enable results to be more widely generalised.

The first motivation for this research in this thesis is to investigate the cooking and other food-related activities of older adults' to discover if there is a need for potential technological support.

The second motivation for this research in this thesis is to understand if the assumptions of the earlier food related interactive systems generalise to a wider population.

Bell and Kaye (2005) compared the ways that people lived in and used kitchens across several countries and contrasted that with the approach of smart kitchen technology. They argued that the smart kitchen goal to create an efficient and error-free cooking environment was distinctly North American and an approach taken from the work place that was not appropriate in the domestic realm. They argued that to put this right technologists must make "a concerted effort to learn from the mistakes of the last hundred years" (p60) and "better understand what people are already doing in their domestic spaces and design around those activities" (p58).

Here lies the missing part in the previous research and the motivation for the research in this thesis; few researchers in the human-food interaction field of HCI have entered the kitchen and observed people cooking before setting out to design and implement systems designed to solve the problems of cooking. For example in developing the concept for *PersonalChef* (Mennicken et al., 2010), the researchers talked to "hobby chefs" to discover that they liked watching cooking shows but did not cook from them, preferring to cook from textual recipes or no recipe at all. The system was then designed to reduce disappointment of failed recipes and increase cooks' confidence, neither of which problems were referred to their brief user research or observed in cooks preparing recipes.

In fact few researchers, in any discipline, have observed cooks in action in the domestic kitchen. Social and health sciences have relied upon interview and questionnaires (for example Charles & Kerr, 1988; Larson, Perry, Story, & Neumarksztainer, 2006; Möser, 2010). Such measures, however, are inadequate for measuring cooking skills (Short, 2003). In her thesis (Short, 2002) and subsequent book (Short, 2006), Short argued that attempting to measure cooking skills with checklists of techniques was reductionist and consequently failed to acknowledge the wide range of organisational, planning, management, evaluation and physical skills that were all called into play when people prepared meals, even those meals that made extensive use of prepared food stuffs.

The third motivation for the research is the need to understand what cooks do and the problems they encounter when following recipes, without which it is difficult to develop effective interactive recipe system designs. This approach is in line with User Centred Design (UCD) methodologies such as Contextual Inquiry (Beyer & Holtzblatt, 1997).

Considering the ways that recipes were presented in the earlier interactive recipe systems, several systems introduced multimedia (e.g. Ju et al., 2001), broken up recipe steps into short bullet points (e.g. Mennicken et al., 2010) or accompanied each step with illustrations of utensils needed (e.g. Hamada et al., 2005). These are questions of instruction design about which there is a large body of research in both psychology and HCI. However, none of the earlier systems made reference to this research in designing their systems. Guidelines for developing effective procedural instructions (e.g. Ganier, 2004) provide a framework from which design elements could be systematically applied to the design of interactive recipe systems and their effectiveness evaluated. However, to date, design elements have been applied to interactive recipe systems on an ad-hoc basis and it is not clear if, or how, they work together for the benefit of the cook.

The fourth motivation for this research is to investigate the potential benefit of using guidelines drawn from instruction design research into the design of interactive recipe systems.

When Grimes and Harper (2008) argued that research should move away from negative "corrective technologies" towards more positive "celebratory technologies" they wrote as if these corrective technologies had been successful in their aims. In reviewing the literature it became clear however that few of the systems were evaluated against the claims that were made for them. For example *CounterActive* (Ju et al., 2001) was designed to help novices learn to cook, *PersonalChef* (Mennicken et al., 2010) was designed to increase the confidence of hobby chefs preparing a new dish and *HappyCooking* (Hamada et al., 2005) was designed to enable cooks to prepare several dishes in the optimal time. None of these studies, however, took measures that related to these claims or reported comparative evaluations of their system against a control. These data are essential not only to support the claims that a system does what it claims to do but also to provide the foundations upon which future researchers can develop better knowledge.

The fifth motivation for this research is to provide comparative evaluations that can demonstrate what aspects of design work and what do not thus providing the foundations on which future researchers can build.

1.3 Research aims and objectives

This thesis presents four studies. Study one is a qualitative study conducted using focus groups to investigate the food related activities of older adults and if the design assumptions of interactive systems to support food related activities such as meal planning, shopping and cooking, generalise to older adults. Study two is a qualitative study conducted using a food and shopping diary and post-diary interview to extend the previous study and triangulate the data. Studies three and four take a mix of qualitative and quantitative approaches to build a rich picture of how cooks use recipes. They took an experimental design in order to compare cooks' behaviours, problems and errors while using recipes in different presentations. The findings of cooks' behaviours and the effects of different recipe presentation designs can be used to inform the design of future interactive recipe systems.

In pursuing the overall aim, the research objectives were to:

- Investigate the cooking and other food-related activities of older adults to discover if there is a need for technological support
- Investigate if and how the assumptions of earlier food related interactive systems generalise to older adults
- Apply theory and guidelines from instruction design research to recipes in interactive recipe systems
- Describe how cooks use recipe instructions, identify the strategies used and problems experienced with different interactive recipe formats
- Evaluate cooks' experience and success in following recipes across different interactive recipe formats

Table 1 shows a summary of the studies in this thesis, the objectives of each and the methods used in each study.

Table 1: Summary of studies, objectives and methods employed

Chapter	Study name	Objectives	Methods employed
3	Focus groups	Investigate food related activities of older adults Test assumptions of literature with older adults	Focus groups
4	Food and shopping diaries	Investigate food related activities of older adults Test assumptions of literature with older adults Triangulate data from Focus groups study	7-day diary Interviews
6	RECIPE1: segmented & integrated	Test effect of short recipe steps Test effect of integrated recipe instructions Understanding how cooks interact with recipe instructions	Observation Comparative evaluation of problems and errors
7	RECIPE2: pictures & overview	Test effect of pictures with recipe steps Test effect of overview presentation of recipe instructions	Observation Comparative evaluation of problems and errors

1.4 Contributions of the research

The studies in the first part of the thesis were designed to investigate older adults' cooking and other food-related activities and if and how the assumptions made in the earlier research generalise to older adults.

The studies in the second part of the thesis were designed to provide a rich understanding of how cooks interact with recipe instructions and the effect of different formats of recipe instructions. In particular the contributions of this thesis:-

- From the first two studies:
    - Show that older adults do not need technological support for their cooking and food-related activities.
    - Show that design assumptions of food related systems do not generalise to older adults.
- From the last two studies:
    - Show that cooks do not follow recipe instructions in sequence so interactive design should strive to support this non-sequential behaviour.
    - Show that the format and structure of information within recipe instructions has an effect on how cooks use the instructions so must be considered when comparing success of interactive recipe systems.
    - Show that guidelines for instruction design can inform the design of recipe instructions for interactive recipe systems.
    - Show that the majority of cooks' problems with recipes relate to content. When evaluating the effectiveness of an interactive recipe system, future researchers should how the intended audience of the recipe instructions relates to the participants recruited to evaluate the system.
    - Demonstrate a methodology for evaluating future interactive systems against a traditionally formatted recipe.

Chapter 2 Literature Review

2.1 Introduction

Within HCI, a number of systems have been proposed to help people with human-food interactions including cooking, planning meals and shopping. The first part of this chapter is a review of the literature that describes systems to support the tasks of cooking. Other systems that support planning meals and shopping are reviewed in subsequent sections.

A number of systems have been designed to help people follow recipes in the kitchen, for example *CounterActive* (Ju et al., 2001), *PersonalChef* (Mennicken et al., 2010), *Panavi* (Uriu et al., 2012) and others, for example *CooksCollage* (Tran et al., 2005) to help cooks overcome problems of distraction experienced in the kitchen. These systems contribute to the discipline with innovative designs including instructions located where the cook will perform the task (e.g. Bonanni et al., 2005), obscured computers (e.g. Ju et al., 2001) and life size chefs to inspire confidence (Mennicken et al., 2010). Few researchers, however, based their design solutions on empirical studies of cooks' problems or evaluated their systems for effectiveness and as a consequence there are few valid and useful results for practitioners to take to inform the design of future interactive recipe systems.

Underlying the literature describing interactive recipe systems are two key assumptions that will be developed in this chapter. The first assumption is that recipes are familiar and known and therefore carry no need for examination in how they are used. The second assumption is that cooks' problems are known. These assumptions emerge from a reading of the literature that notes an absence of any description of recipe content, structure and presentation in the systems and the absence of empirical research investigating how cooks perform tasks with traditional paper based recipes and the problems they might encounter.

2.2 Recipes and instruction design

In order to discuss the recipe design in interactive recipe systems, I need first to introduce and describe what a recipe is in more detail. Dissecting the anatomy of a traditional formatted recipe will introduce the language to describe different parts and provide an insight into why recipes are far from being neutral sets of instructions.

2.2.1 Traditional recipe format

The common and familiar format of a cooking recipe comprises a title and "a standard two-part format: (1) the list of ingredients, and (2) the instructions" (Tomlinson, 1986, p. 203). The form has evolved from earlier narrative forms of recipes (Carroll, 2010) and is seen in both French as well as English recipes (Hertzmann, 2010). It was first seen in English cookbooks in 1845 in a book by Elizabeth Acton and in 1861 from Mrs Beeton (Carroll, 2010; Fisher, 2001). The format crossed the Atlantic to USA and appeared in the "Boston Cooking-School Cookbook" by a "Miss Fannie Merritt Farmer" in 1896 (Fisher, 2001). The format, which is visually distinct from other text (Carroll, 2010) and has become the "standard in recipe writing" (Hertzmann, 2010, p. 171), is now ubiquitous and rarely critically examined (Cotter, 1992).

In describing the elements that make up recipes and the relationships between them, I will use examples from recipes for tomato sauce. Despite the simplicity of the dish, there are many ways to make it and "potentially limitless ways [the recipe may be] linguistically presented" (Cotter, 1992, p. 54). Both recipes shown below conform to the two-part format described by Tomlinson (1986) and serve to illustrate a number of variations within this format.

2.2.1.1 Two-part form of a recipe

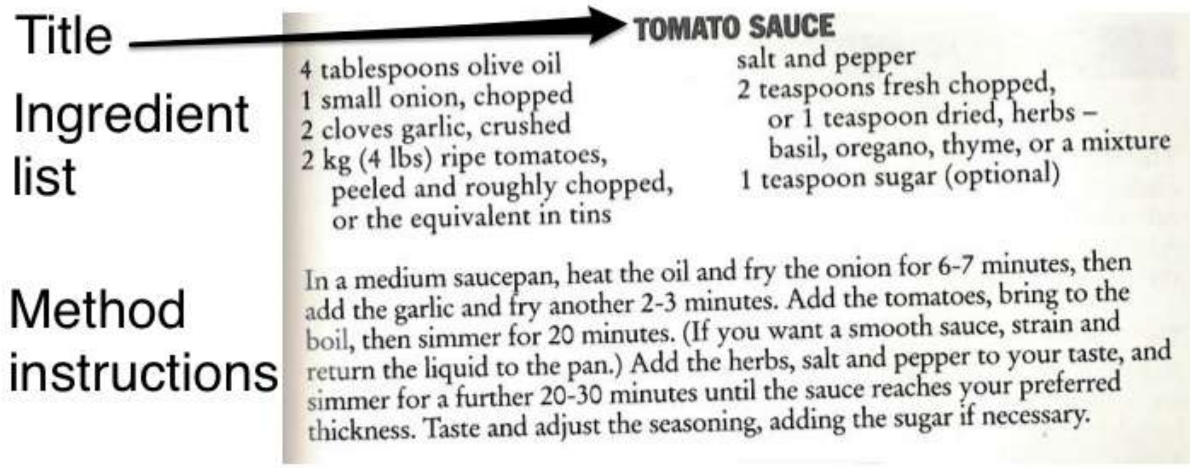
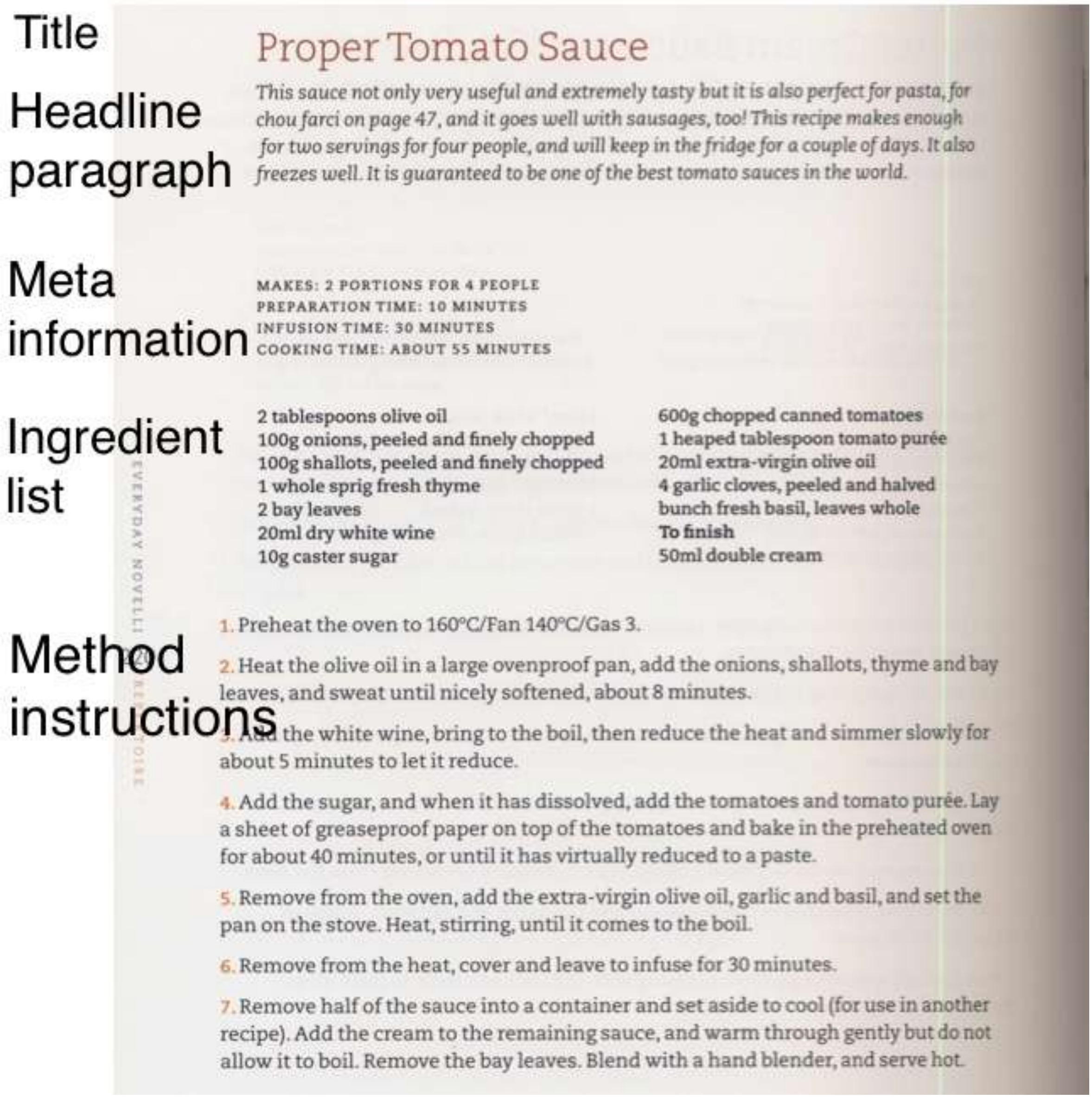


Figure 1: Recipe for "Tomato Sauce"

Figure 1 shows a recipe for tomato sauce from Janet MacDonald's "The Basic Basics. How to Cook from A to Z" (1998). The recipe is presented in two parts: the *ingredient list* and the *method instructions* presented in a single paragraph. Figure 2 shows another recipe for tomato sauce from Jean-Christophe Novelli's "Everyday Novelli" (2009). Novelli's recipe differs from MacDonald's recipe in several ways. It adds a headline paragraph to entice the reader to make the recipe and meta information about yield and preparation times. The recipe body retains the same two-part structure but the *method instructions* differ - they are presented in a series of numbered paragraph steps.



Proper Tomato Sauce

This sauce not only very useful and extremely tasty but it is also perfect for pasta, for chou farci on page 47, and it goes well with sausages, too! This recipe makes enough for two servings for four people, and will keep in the fridge for a couple of days. It also freezes well. It is guaranteed to be one of the best tomato sauces in the world.

MAKES: 2 PORTIONS FOR 4 PEOPLE
PREPARATION TIME: 10 MINUTES
INFUSION TIME: 30 MINUTES
COOKING TIME: ABOUT 55 MINUTES

2 tablespoons olive oil
100g onions, peeled and finely chopped
100g shallots, peeled and finely chopped
1 whole sprig fresh thyme
2 bay leaves
20ml dry white wine
10g caster sugar
600g chopped canned tomatoes
1 heaped tablespoon tomato purée
20ml extra-virgin olive oil
4 garlic cloves, peeled and halved
bunch fresh basil, leaves whole
To finish
50ml double cream

1. Preheat the oven to 160°C/Fan 140°C/Gas 3.
2. Heat the olive oil in a large ovenproof pan, add the onions, shallots, thyme and bay leaves, and sweat until nicely softened, about 8 minutes.
3. Add the white wine, bring to the boil, then reduce the heat and simmer slowly for about 5 minutes to let it reduce.
4. Add the sugar, and when it has dissolved, add the tomatoes and tomato purée. Lay a sheet of greaseproof paper on top of the tomatoes and bake in the preheated oven for about 40 minutes, or until it has virtually reduced to a paste.
5. Remove from the oven, add the extra-virgin olive oil, garlic and basil, and set the pan on the stove. Heat, stirring, until it comes to the boil.
6. Remove from the heat, cover and leave to infuse for 30 minutes.
7. Remove half of the sauce into a container and set aside to cool (for use in another recipe). Add the cream to the remaining sauce, and warm through gently but do not allow it to boil. Remove the bay leaves. Blend with a hand blender, and serve hot.

Figure 2: Recipe for "Proper Tomato Sauce"

In both recipes, the *ingredient list* contains a list of ingredients to gather, measure and the tasks to perform on them. The quantity associated with the ingredient describes an implicit task for the cook to gather and measure the ingredient, for example, figure 1 includes a task to measure 4 tablespoons of olive oil. *Preparation instructions* describe a task that must be performed on an ingredient before it is used in the *method instructions*. For example in Figure 2, the cook should take 100g of onions and the peel and finely chop them.

The *method instructions* contain the main part of the procedure to make the recipe. *Method instructions* are presented in various forms: figure 1 shows them in a single paragraph, figure 2 shows them in a series of numbered steps.

At first glance the procedure described in a recipe appears straightforward and unambiguous. To prepare the recipe each ingredient must be collected and measured and prepared according to the instructions in the ingredient list and then combined and heated according to the method instructions. The combination of instructions in both ingredient list and method instructions are needed to describe the procedure to make the recipe. This appears straightforward, indeed, the American Copyright Office considers recipes to be scientific fact and therefore not amenable to copyright (Kapoor, 2010). If we, however, consider the contents and distribution of information in the recipe and how the cook must combine it to create a procedure it looks far from straightforward.

2.2.1.2 Following the method instructions

Considering the content and structure of *steps* within the *method instructions*, Cotter (1992) notes that recipe instructions rarely include temporal markers, e.g. “next”, indeed Whitman (1993, p67) lists them as unnecessary words. As a consequence the sequence of tasks is implied by the order of instructions, however, the tasks described in *steps* within *method instructions* are not always sequential: they contain backwards references and overlapping tasks.

BBC FOOD bbc.co.uk/food

Honey flapjacks

Ingredients

- 200g/7¼oz unsalted butter
- 200g/7¼oz demerara sugar
- 200g/7¼oz honey
- 400g/14¼oz porridge oats
- 50g/1¾oz nuts, dried fruits or glacé ginger, chopped or desiccated coconut (optional)
- You will also need a 20cm x 30cm (8in x 12in) cake tin, greased

Preparation method

1. Put the butter, sugar and honey in a saucepan and heat, stirring occasionally, until the butter has melted and the sugar has dissolved. Add the oats and nuts, fruit, ginger or coconut, if using, and mix well.
2. Transfer the oat mixture to the prepared cake tin and spread to about 2cm (¾in) thick. Smooth the surface with the back of a spoon. Bake in a preheated oven at 180C/350F/Gas 4 for 15-20 minutes, until lightly golden around the edges, but still slightly soft in the middle. Let cool in the tin, then turn out and cut into squares.

less than 30 mins
preparation time
10 to 30 mins
cooking time
Makes 12

By Celia Brooks

The best flapjacks are gooey, chewy and, above all, simple. These fruit-filled treats are great to make with children.

Figure 3: Recipe for Honey Flapjacks from BBC Good Food website

A backwards reference is one which tells the cook they should have done something earlier in the procedure. For example, Figure 3 shows a recipe for Honey flapjacks with the classic "Bake in a preheated oven …" instruction that tells the cook they should have turned on the oven some time before. For the cook who stumbles across this type of instruction after putting the cake batter into a tin and smoothing the surface, the effect on confidence and on the cake can be disastrous.

Meatballs with Tomato Sauce

A GROWN-UP VERSION OF A KID'S DELIGHT. I remember hating meatballs as a child, as my Nana used to cook them all the time, but they were truly awful, always from a tin and never heated through, and served with a mound of overcooked rice. My sister and I used to be made to sit through this ordeal, and we weren't allowed to leave the table until we had finished. I used to hide mine, anywhere and everywhere I could ...

SERVES 4

2 shallots, peeled and chopped
1 garlic clove, peeled and chopped
olive oil
450g (1lb) tail of beef fillet
2 tsp Dijon mustard
splash of Worcestershire sauce
50ml (2fl oz) double cream
salt and freshly ground black pepper

FOR THE BASIC TOMATO SAUCE
1.5kg (3lb 5oz) ripe and meaty tomatoes
4 tbsp olive oil
1 medium onion, peeled and very finely sliced
1 garlic clove, peeled and coarsely chopped
1 tbsp chopped fresh oregano
10 small fresh basil leaves, shredded

1 For the tomato sauce, plunge the tomatoes into boiling water for 1 minute to loosen the skin. Remove the skin, and cut the tomatoes in half. Discard the inner liquid and seeds, leaving only the flesh, which you coarsely chop.

2 Heat the oil in a pan and fry the onion for 5 minutes. Add the garlic and fry for a further minute. Add the tomatoes and bring to the boil, then add the oregano, reduce the heat and simmer for 30–40 minutes. Halfway through, add the basil leaves.

3 When the sauce has finished cooking, add some salt to taste, and liquidise. Keep warm. (It keeps for a few days in the fridge, but is best if eaten when freshly made.)

4 Meanwhile, to make the meatballs, sauté the shallots and garlic quickly in a little oil to take off the rawness, then allow to cool. Mince the beef through the fine plate of a mincer into a bowl. Add the shallots, garlic, mustard, Worcestershire sauce and cream. Beat well together, then season to taste with salt and pepper.

5 Using a little oil on your hands, shape the mixture into 8–10 even-sized shapes about the size of a golf ball. Leave for 10 minutes, covered, in the fridge to firm up.

6 Preheat a pan on the stove and add a little olive oil. Fry the meatballs until golden brown all over, and serve with the warm tomato sauce.

Figure 4: Recipe for Meatballs with tomato sauce

"Meanwhile...." Figure 4 shows another way in which recipe instructions are non-sequential and how tasks in different steps overlap. Step 4 starts with the word "Meanwhile...". This indicates that the cook should perform step 4 while a task in an earlier step continues. In this recipe the sauce is set to simmer for 30 minutes in step 2 and liquidised and set to keep warm in step 3. It may be possible for the cook to start preparing the meatballs, as described in step 4, while continuing to monitor the sauce simmering, as described in step 2. In this way two steps (step 2 and step 4) are current at the same time.

2.2.1.3 Integrating preparation instructions into the method instructions

The *preparation instructions* within the *ingredients list* sit outside of the method instructions yet must be performed as part of the recipe procedure. "One very obvious observation that can be made with respect to these ingredients is that instructions are presented well before the "instructions" are listed" (Tomlinson, 1986, p. 206).

The cook has to decide when to plan the *preparation instruction* tasks into the overall procedure described in the *method instructions*. One option is to measure all the ingredients and perform all the *preparation instructions* before starting tasks in the *method instructions*. This is known as *mise-en-place*. However, consider the recipe in figure 1. The *preparation instructions* include the tasks to chop the onions, crush the garlic, chop the tomatoes. The onions are used in the first task of the method instructions but the garlic is not introduced until the onions have cooked for 6-7 minutes. The tomatoes are not introduced until after the garlic has cooked for a further 2-3 minutes. If the cook took a just-in-time approach to performing the preparation instructions, they could crush the garlic while the onions are cooking and then chop the tomatoes while the garlic is cooking and potentially reduce the overall time taken to complete the recipe. In doing so, however, the cook has to attend to the instructions in both the ingredient list and the method instructions, and hold them in mind while they "mentally elaborate the steps [using their knowledge of how long different tasks take to perform and] translate them into a set of projections, intentions and expectations - an activity plan" (Kirsh, 2011, p. 1).

Little is known of how domestic cooks integrate the preparation instructions with the method instructions and what problems they might encounter as they do so. Tomlinson (1986) assumes that cook will want to assemble ingredients before setting about the method instructions. Albala and Nafziger (2010) argue that mise-en-place assumes a professional approach to cooking that does not translate to the domestic kitchen and recipes should be re-written to reflect this. Advice to recipe writers, however, continues to support splitting the instructions in order to reduce the length of the method instructions (Gibbs Ostmann & Baker, 2001; Jacob, 2010) and to fit the demands of page copy editors (Hertzmann, 2010) irrespective of the cognitive demands placed on the cook when following the instructions.

2.2.2 Instruction design guidelines

Instructions describe the tasks needed to achieve a goal. The goal might be a one-off, such as arriving at a particular destination after following driving instructions from a Global Positioning System (GPS) device (e.g. TomTom[2]) or presenting a special dish after following recipe instructions. In either case the "completeness and detail of stepwise instructions" (Eiriksdottir, 2011, p. 756) is critical to ensure the successful completion of the individual tasks and overall satisfaction of the goal. Other instructions are written as examples of how to achieve specific goals but with the purpose that the user learns how the underlying system works and can later generalise this knowledge. For example in *The Minimal Manual* (Carroll, Smith-Kerker, Ford, & Mazur-Rimetz, 1987) Caroll presented guidelines for designing concise instructions that would encourage users to engage and explore systems such as word-processors, and in the process of which would encourage rapid learning of how to use the system.

Recipe instructions are written so they can be successfully completed on first or initial use, and seldom with the goal that cooks will learn and generalise from the procedure described. Ganier (2004) developed guidelines for writing

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[2] http://www.tomtom.com/en_gb/

instructions in this situation. The goal of his guidelines is to minimise the cognitive load experienced by the instruction user. Cognitive load is experienced when, for example, the user switches attention from reading instructions to the task and they must keep the current instruction in working memory, elaborate it and apply it to the task in hand and they must keep it in memory again when they return to the instructions and they have to search for their place again to find the next instruction. According to Ganier's guidelines, to minimise cognitive load, instructions should be organised overall in a chronological and linear manner and divided into sub-goals, each clearly and precisely headed, and delivered in individual numbered steps to help users keep track of their progress. Pictures should be included because they enable users to directly map instructions to the task (Mayer, 2001).

Steehouder et al. (2000) supports the principle of organising instructions into goals and sub-goals. They argued further, that instructions should be made meaningful so that users understood why they were doing something. In order to achieve this, instructions need to include some declarative information that is, information that describes the underlying system.

The question of how and when declarative information is used and what form of information is useful is an area of recent research (e.g. Eiriksdottir, 2011; Karreman, Ummelen, & Steehouder, 2005) with questions still open. It is clear however that adding extra information increases the length of instructions and researchers have consistently found that users resist reading instructions, particularly lengthy instructions or those they consider irrelevant (e.g. Carroll et al., 1987; Wright, 1981). One reason may be prior experience with poorly written instructions (Wright, 1981), another the cognitive effort required to read, understand and elaborate highly detailed instructions (Ganier, 2004). Thus, in the process of writing instructions there is an inherent tension between being concise and providing sufficient detailed information.

Considering how guidelines for generic procedural instructions map to the traditional format of recipes it is clear that recipes do not provide instructions in a chronological and logical manner and often do not provide instructions in numbered steps. Recipe instructions are split across the ingredient list and the method instructions increasing the cognitive load of cooks who have to integrate the information from split sources (Chandler & Sweller, 1991). Further, instructions often refer backwards (e.g. “in a pre-heated oven”) or describe tasks that require several instructions to be performed at once. Some recipes, e.g. the tomato sauce in figure 2 are presented in numbered steps, others e.g. the tomato sauce in figure 1 are presented in paragraphs reducing the ability of cooks to quickly find their place when they return to the instructions after performing a task. Finally, recipe instructions tend towards concise wording, minimising the additional declarative information that may otherwise assist cooks unfamiliar with the particular dish or technique being described. If interactive recipe systems could reorganise recipe content from the traditional format to follow these guidelines for effective procedural instructions this could improve the experience and success of cooks using the recipes.

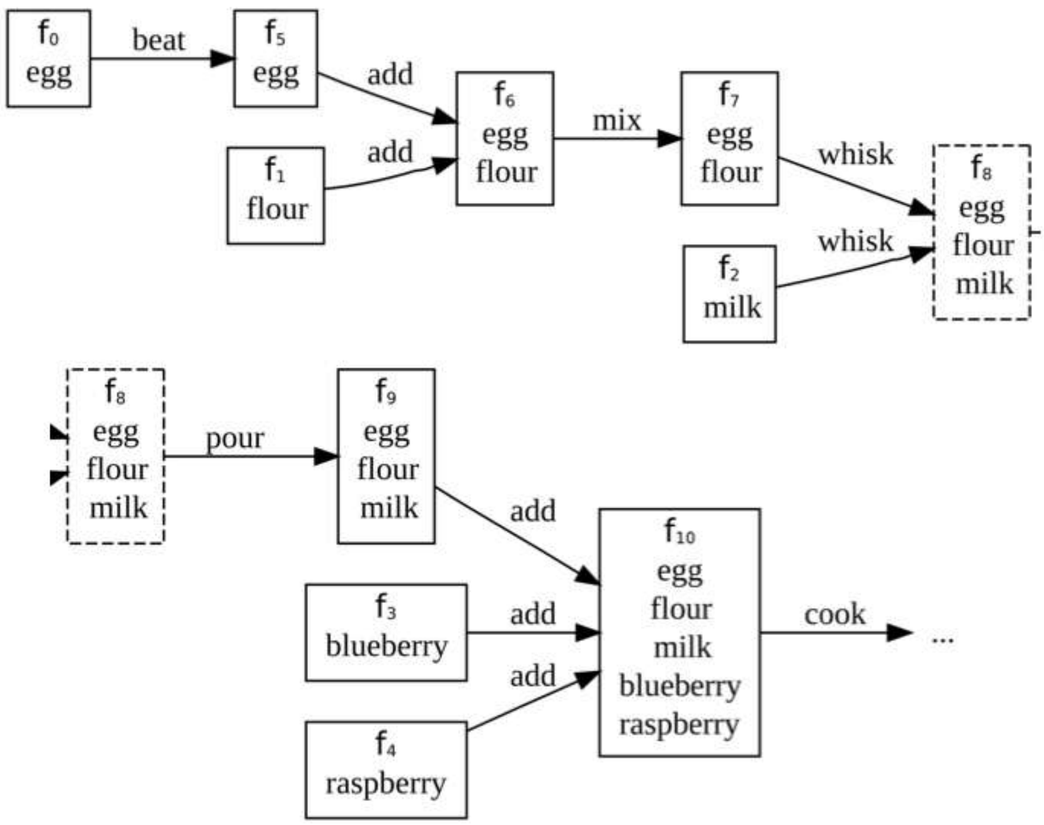

Figure 5: Recipe tree for Easy Berry Pancakes recipe

Recent research in the domain of Natural Language Processing suggests it may be possible to restructure the text of recipes through the generation and manipulation of "recipe trees" or "recipe graphs" and associated textual manipulation. Figure 5 shows a "recipe tree" generated from a recipe for Easy Berry Pancakes (Dufour-Lussier, Lieber, Nauer, & Toussaint, 2010). The tree presents a formal representation of the recipe text. It comprises nodes representing ingredients that are progressively combined into mixtures towards a single final product. The goal of Dufour-Lussier et al. and others (e.g. Makino, Kobayashi, Izumi, & Hasida, 2009) is to identify substructures of processing within the recipe tree that could be snipped out and substituted with similar structures from other recipes in order to, for example, substitute aubergine for zucchini. Other researchers (e.g. Wang, Li, & Li, 2008) have investigated the use of recipe graphs to support searches for recipes that have a similar structure but do not share common ingredients or titles. While the goals of these researchers does not exactly match the goal of reorganising and restructuring recipe instructions to match instruction design guidelines, it does suggest that algorithms that would be required are possible and may indicate a potential route for future interdisciplinary research that could integrate the means to reorganise and adapt recipe texts for effective interactive recipe systems.

2.2.3 Evaluating the different instruction designs

In order to evaluate the success of such new recipe designs a number of methodologies have been developed to test different forms of instructions both within psychology (e.g. Karreman & Steehouder, 2004; Ummelen, 1997) and within HCI (e.g. Fothergill, Mentis, Kohli, & Nowozin, 2012; Tang, Owen, Biocca, & Mou, 2003). Ummelen (1997) developed a "click and read" method that was later refined by Karreman and Steehouder (2004) to measure the time different parts of the instructions were visible on the screen and therefore available for the user to read. This enabled the researchers to investigate the relative importance of declarative information in procedural instructions but it could equally be applied to investigating the relative importance of information in the ingredient list compared to method instructions or of pictures compared to textual instructions.

Researchers in HCI have investigated the effectiveness of instructions delivered in different formats and in different media. For example, Tang et al., 2003 investigated the use of augmented reality to deliver instructions directly onto materials used in a task, Bruun & Stage (2012) investigated the content and design of instructions to assist in remote usability testing and Fothergill et al., 2012 investigated content of instructions to help users train gesture recognition game controllers.

In each of these studies, an evaluation was performed that compared the success rate of users performing the same task across different forms of instructions. For example, Tang et al (2003), compared two forms of augmented reality instructions with instructions presented on a computer and on paper. Instructions were provided to assemble a model using Duplo blocks and researchers measured the time taken to complete the task, the number of errors made and the cognitive load using the NASA TLX questionnaire. Fothergill et al., (2012) compared three forms of instruction -textual, still graphics and video. The instructions told users how to move their bodies and produce gestures that would train the games controller gesture recognition systems and the researchers measured user preferences with a post-task questionnaire and interview and gesture recognition success rates.

In the sections that follow, I shall describe interactive recipe systems developed by HCI researchers. These systems delivered recipes with interactive technology and multimedia designed to provide a different experience from using recipes in a cookbook. The designers also altered the organisation of information within recipes and the structure of recipe instructions but few of the researchers described how they designed their recipe instructions and few performed evaluations to test the effectiveness of either the recipe format or of the interactive media through which it was delivered.

2.3 Interactive recipe systems and instruction design of recipes

2.3.1 CounterActive

The *CounterActive* system (Ju et al., 2001), described as an "interactive cookbook that teaches people to cook" (p269) is cited by more than 100 papers (September 2012). The system was designed with two key points in mind: to obscure the sense of interaction with a computer and to provide an exciting interface that would "entice people to explore cooking and help them prepare food" (p269). The computer was obscured from the cook by projecting the visual interface onto the kitchen work surface in which an electric field was set to sense the cooks' interactions.

Figure 6: User interface of CounterActive

Starting at top left of Figure 6, three areas were spot lit for cooks to work in. Below this the ingredients for the current step were illustrated with associated quantities needed and below this the current recipe step. Cooks who chose to use to the spot lit areas had to lean over the instructions to reach them. To the top right was a picture of the utensils needed for the current step and a large area for still pictures and videos illustrating the technique of the current step.

The *CounterActive* system was evaluated by two participants, each of whom prepared one recipe and was interviewed afterwards about their experience. The participants were a 7-year old and a 10-year old child. No further information was provided about the participants, and it is not clear why children where chosen to perform the evaluation.

The authors observed the cooks' activities during the cooking sessions. Despite having to lean over the recipe instruction area, the cooks spontaneously used the spot lit areas for performing the recipe tasks. Their task activities were driven more by the still image and video clips than the textual instructions. For example, they watched each video clip several times and took the visuals literally - selecting the same utensils as were shown in the video. If more than one task was described in the instructions they performed the first task and skipped the later ones.

The recipes for *CounterActive* were chosen because they had “instructions and procedures that were safe and fun” (p270) but it is not clear if they were reworded or restructured from an original source or if they were written afresh to support the design motivations. It was not clear if preparation instructions and quantities of ingredients were included in the recipe instructions. Considering the design motivations of *CounterActive*, to entice people to cook and to help them cook, no measures were taken to evaluate the success of the system in comparison with, for example, a well written and well illustrated paper recipe. Further, in selecting children in the concrete operational stage of development (Piaget, 1952) it is not possible to distinguish if instances of behaviour, such as taking the pictures literally, relate to the age of the participants or to the design of the interface.

2.3.2 eyeCOOK

The design of *eyeCOOK* (Bradbury, Shell, & Knowles, 2003; Shell et al., 2003) used audio to present recipe instructions in order to reduce demand on the cook’s visual attention. The system was designed to “improve productivity and user satisfaction without creating additional requirements for user attention” (p996). A similar, but anonymous, system was developed by Martins, Pardal, Franqueira, Arez, & Mamede (2008) to “help the user by dictating the needed steps while his hands and eyes are occupied with the cooking tasks” (p145). For both systems the cook controlled the recipe system with voice commands. A limited command vocabulary was created for each system to enable to cook to move the recipe to the next or previous step and to ask for more detailed information about an ingredient or technique. The *eyeCOOK* system also incorporated a proximity based display using eyetracking technology. When the cook was far from the display, the current recipe step was displayed in large text so it could be seen from a distance; when the cook approached the display, the whole recipe was displayed in smaller text.

Neither of the systems described above were evaluated by cooks so there is no evidence available to support the claim that audio controlled interactions and audio delivery of recipe instructions would improve the productivity or user satisfaction of cooks or reduce their need to look at and read recipe instructions.

2.3.3 Kitchen of the Future

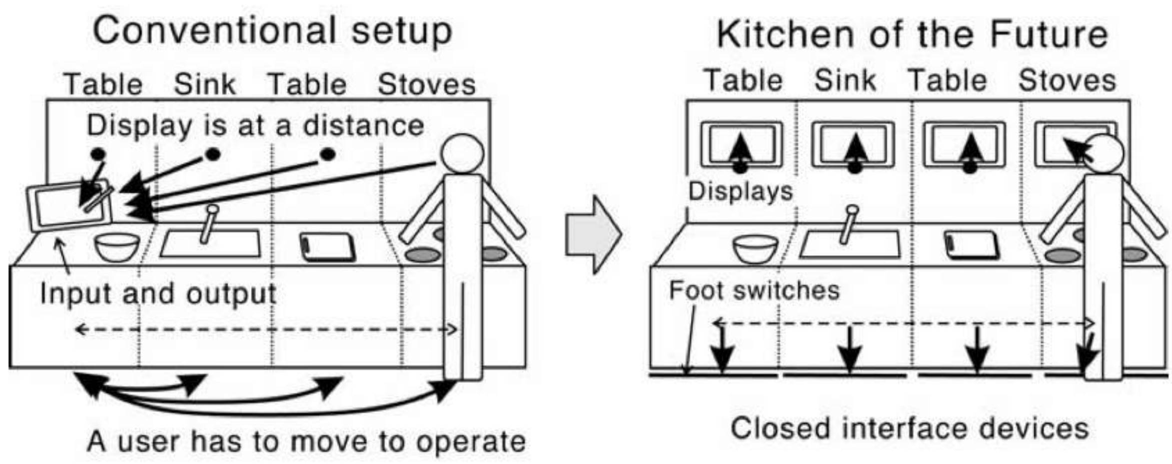

Figure 7: Kitchen of the Future

Figure 7 shows two kitchen layouts that incorporate an interactive recipe system. In the layout on the left the recipe system *CookingNavi* (Hamada et al., 2005) is shown implemented on a single display to the left of the kitchen. In this "conventional setup" the cook has to move to the display to read the recipe or watch videos and return to the stove or table to do the work. In the *Kitchen of the Future* (Siio et al., 2007; Siio, Mima, Frank, Ono, & Weintraub, 2004) layout, the recipe system (now renamed *HappyCooking*) was implemented over four displays, one at each section of the kitchen enabling the cook to see the instructions and videos where they worked. The foot switches enabled the cook to move onto the next step in the recipe.

In the original design of *CookingNavi*, Hamada et al. shared the view with Ju et al. (2001) that recipe instructions, when provided in timely manner, would optimise learning potential for cooks and support them to accurately and efficiently prepare a recipe. Hamada et al, wanted to solve a particular problem: how to organise the tasks of more than one recipe so the recipes could be completed in the shortest possible duration and at the same time. In addressing this problem they considered that some tasks in recipes were candidates for being performed in parallel with other tasks. This parallelisation would reduce the overall time taken to complete the recipes.

To develop their system, Hamada et al. used videos from Japanese TV cooking shows. They developed a technique to analyse the videos and identify individual cooking tasks shown on the video (Hamada, Ide, & Sakai, 2000; Hamada et al., 2004). Each cooking task corresponded to a "shot" on the video, although some video "shots" contained more than one cooking task. For each cooking task they identified the resources needed for the task (including the cook, utensils, appliances etc) and any dependencies it had on other cooking tasks. Having done this they were able to calculate a graph of the optimal path through the tasks of any two recipes, including where tasks could be performed in parallel. This used the "meanwhile…" nature of some recipe steps.

In their earlier work (Hamada et al., 2000) the authors describe the semantic algorithm to structure recipe steps from an original text. They identified ingredient nouns from the ingredient list and verbs in the instructions and created recipe steps based on verb-noun pairs and then calculated the connections between recipe steps based on the ingredients used in each step. It was not clear from illustrations of the system if preparation instructions and ingredient quantities were presented separately in an ingredient list or incorporated into the method instructions.

The authors evaluated the success of the algorithm compared to a human structuring the same recipe according to the same rules. Their algorithm had success of accuracy of 46% when run against one recipe video and 82% when run against another. The cause of the wide range of accuracy was not investigated so it was not clear from this study what factors of recipe design would lead to a more accurate transformation with the algorithm. The authors did not report if any cooks were involved in reviewing the semantic algorithm or the results produced from it, or if style and readability were included in the evaluation measures.

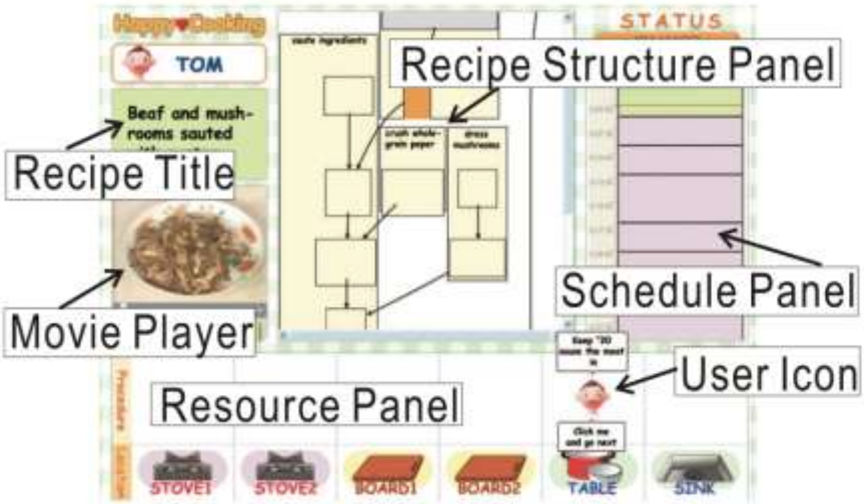

Figure 8: User interface of CookingNavi

Figure 8 shows a screenshot of the *CookingNavi* system as it was displayed to the cook. In the top left hand area was the recipe title and a video clip of the current recipe step playing in a continuous loop. In the top middle area was the graph of the recipe tasks showing their interdependencies. In the top right area were the textual instructions for the cooking tasks, presented in sequence. It is not clear how parallel tasks were identified to the cook. In the bottom area of the screen was the resource panel that showed where the cook should perform the current task.

Eight cooks evaluated the system. Two of the cooks were described as experienced, three as intermediate and three as novice. Neither the criteria for these skills ratings or any further details about the cooks was reported. Four recipes were prepared for the system and each cook prepared two of these in their evaluation session, completed a post-cooking questionnaire and were asked for verbal feedback about their experience. The questionnaire asked cooks to rate their use of the system over six statements on a scale of 1 to 10. The mean scores were calculated over all eight cooks, and then split across three skill levels of cooks.

Considering the design motivations to help cooks perform accurate and efficient reproduction of recipes with an optimised learning potential, no measures were taken of the errors made, time taken to complete, learning effects and no comparative evaluation was made between cooks using the system and using paper recipes. The structure of the recipe steps was not evaluated by a cook. The authors' conclusions about the system were drawn from the mean scores given on the post-cooking questionnaire and the verbal feedback from the cooks. All cooks, including the experienced cooks, rated the video highly and were reported to say they needed the video to complete the recipes. It seems that either the recipes used were very difficult or the experienced cooks were not so experienced. All cooks rated the system as preferable to paper recipes. I found this a surprising result. Firstly the novice cooks, who had not previously cooked and had no experience to draw on, could not be expected to make a comparative rating. And secondly all cooks reported difficulties using the system, particularly in relation to tasks that were meant to be performed in parallel. The designers however claimed their system successfully helped cooks and concluded that additional work was needed to identify the type of tasks that would feel more "natural" to be performed in parallel.

2.3.4 VERA

VERA (Tee et al., 2005) was designed to help people with language impairments, e.g. aphasia. In designing *VERA*, Tee et al. took a multimedia approach to support varying abilities of people with aphasia. The design of recipe instructions was in two stages. Tee et al. first developed a semantic model of recipe instructions and then translated this into a visual culinary language “that allow[ed the] primarily visual cooking instructions to be customised to each individuals’ strengths” (p501). Then they created a simple prototype interface with these visual recipe instructions on a sequence of “cards” on separate screens and supplemented them with textual and audio versions.

VERA was evaluated by four participants with varying degrees of aphasia. Two recipes were presented to each participant, one for cookies, one for spaghetti sauce and one was presented as a text-only recipe on paper and one presented on VERA. The text-only recipe had an ingredient list but it was not clear if preparation instructions were in the ingredient list. The participants took part in three sessions, the first two being cooking sessions where they prepared one of the recipes and the final session consisted of a language assessment. During the cooking sessions, the participants were supported by a helper who intervened if the participant struggled with reading an instruction or was unsure what to do. Following each cooking session the participants were asked to rate the ease of use, comfort level and preference for the recipe presentation. The findings showed the number and severity of interventions did not vary between cooking sessions where *VERA* and the paper recipe were used. It did vary between participants and results suggested there was an order effect. Feedback from participants was mixed and suggest that ratings for preference may not have been related to ease of use. For example one participant, preferred the paper recipe because it was more difficult and generated more interventions from the helper. For this participant it made the cooking session more sociable and more pleasurable. The results suggest that further research on the needs of people with aphasia would be required to inform the design of future supportive recipe systems.

2.3.5 PersonalChef

PersonalChef (Mennicken et al., 2010) was inspired by interview research with “hobby chefs” and was designed to “increase users’ confidence and fun when preparing an unknown recipe" (p3403). Figure 10 shows how the system was built into the kitchen with a touch screen in the work surface and a life size display on the wall behind the stove showing the *PersonalChef* preparing each recipe step. Figure 9 shows the user interface of PersonalChef as displayed in the work surface. The recipe instructions are listed in short steps in a column on the left side and, unlike traditional recipes, the text of the instruction includes the quantity of each ingredient referred to. The current recipe step is highlighted with a beige background and alongside the step are pictures of the utensils needed and a large image to illustrate the task to be performed. Cooks could choose the level of support they desired; they could simply follow the textual recipe steps provided on the touch screen work surface or explore the illustrations and watch the videos of each recipe step.

The system was evaluated by 12 cooks aged from 17 to 73-years old (mean=35.75, SD=17.63). The cooks were asked to self-report their cooking skills on a scale of 1 – 5, where 5 was high. The mean score of cooking skills was 3.18. Each cook prepared all three recipes, one in each of three recipe presentations: (1) from a textual recipe, (2) watching a TV show of the recipe 24 hours beforehand and then preparing from a textual recipe, and (3) using the *PersonalChef*.

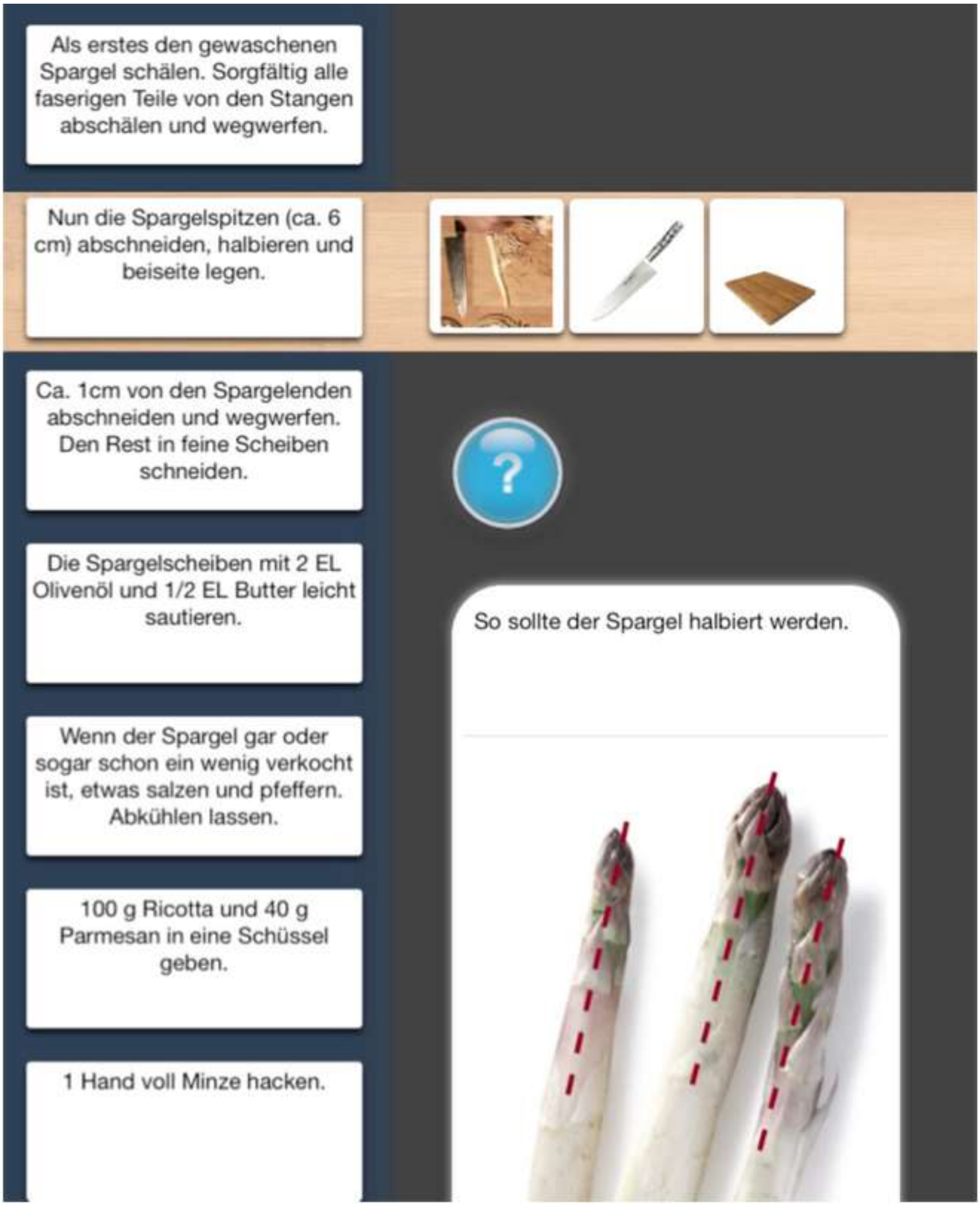

Figure 9: Recipe instructions interface for PersonalChef

The cooks prepared the three recipes, completed a post-cooking questionnaire and then sat down to eat their dishes with friends and the researchers.

Figure 10: Installation of PersonalChef

The authors reported that *PersonalChef* increased the confidence of cooks and from this concluded that it lowered the perceived difficulty of the more advanced recipes. It was not clear how these conclusions were supported from the reported results. No measures were taken of the confidence of the cooks, the authors did not attempt to define what constituted a more advanced recipe and they did not report any results from the conditions where cooks prepared recipes without the support of *PersonalChef*.

2.3.6 Panavi

Panavi (Uriu et al., 2012) was designed with specific aim of supporting domestic users "to master professional culinary arts in their kitchens" (p129). It had one built-in recipe for Pasta Carbonara which is a pasta, pancetta and egg dish. The designers drew on a cookbook recipe for the dish and a video of a Japanese TV chef preparing the dish in order to identify the tasks needed to reproduce the recipe. For each recipe task they wrote the text for the recipe step, associated it with a video clip from the TV chef and, through testing, identified the optimal temperature range of the pan for each recipe step.

Figure 11: installation of *Panavi* system, still from supplemental video, Uriu et al. 2012

Figure 11 shows the installation of the *Panavi* system, comprising a recipe display, an instrumented frying pan and a projector. The recipe display presented the method instructions one step per page. On each page was the textual recipe instructions, a video clip and a countdown timer. The cook chose whether to view the video or not and when to move to the next step. The frying pan was instrumented with a thermometer in the pan and an accelerometer in the handle. The temperature was projected onto the pan (or the mixture in the pan) in a colour according to how close it was to the target temperature: blue when cold, then yellow and green when at target temperature. If the pan became too hot the temperature was projected in red and audible alarm given until the cook took remedial action and cooled the pan. If the recipe step required the mixture to be stirred, for example while making the egg sauce, the handle would vibrate and the system made a buzzing noise to encourage the cook to shake and stir the pan.

The designers took a case study approach to evaluating the system. They reported three evaluations of *Panavi* by (1) one novice cook working alone, (2) one experienced cook working alone and (3) one pair of cooks working together. The level of cooking skills were only briefly described; the novice cook “did not have much knowledge about cooking” (p135) and the experienced cook “having a habit of cooking”. No information was provided about the skill and experience level of the pair of cooks and it is not clear if any of the cooks had ever prepared or were familiar with Pasta Carbonara before the study.

The cooks were videoed from three angles while preparing the dish and then performed a retrospective video prompted protocol. The cooks were found to use the system in different ways. The novice cook watched each video clip several times and as a result took far longer to prepare the dish than expected. His end dish was described as “slightly baked” (p135). Both the experienced cook and the pair of cooks prepared the dish in less time than expected. The experienced cook prepared the dish from the textual instructions seldom referring to the videos. The pair of cooks split the work between themselves, sometimes working from the video, sometimes from the textual instructions. Their resulting dish was described as “slightly sloppy” (p137). It was not clear if there was an objective measure for the perfect dish.

All cooks completed a Pasta Carbonara dish, but none produced the perfect dish the system was designed to support. One reason for this suggested by the researchers was that cooks skipped some or all of the videos. The final cooking step is critical to the success of the recipe, it is when the egg sauce is gently cooked to a creamy finish. This process is difficult to explain in words and the researchers expected cooks to watch the video to get it right but not all did. As with the design for *PersonalChef* (Mennicken et al., 2010), the user interface of *Panavi* enabled cooks to follow the textual recipes and dip into videos when they wanted additional support. In both cases some cooks watched some videos and some did not. In the case of the Pasta Carbonara recipe, where it was important that cooks watch the video for the final step, the researchers realised there was no way to indicate the differing difficulties of recipe steps. Further, timing was a key aspect of the system – each step had a countdown timer – but the researchers realised that the optimal time for different batches of ingredients may vary. They proposed that a solution would be found in adding more technology to sense the cooks' activity to determine their level of skill and adapting the instruction level accordingly.

The case studies showed a variety of behavioural approaches to cooking the recipe but lacking comparative measures they were unable to detect trends in behaviour. Similarly the system was based on a single recipe, written by the researchers, so provided little to indicate how the system and the support it offers might generalise to a wider population of recipes.

2.3.7 Presentation of recipe instructions in interactive recipe systems

The interactive nature of these interactive recipe systems enabled the designers to present recipe instructions in novel ways. Several systems addressed the issue of losing one's place in the recipe by visually highlighting the current step. For example, Figure 9 shows the current step in *PersonalChef* (Mennicken et al., 2010) highlighted in beige. A similar technique was used in the design of *HappyCooking* (Hamada et al., 2005) although it was not clear how parallel tasks were indicated.

Figure 11: Method instruction step in Panavi

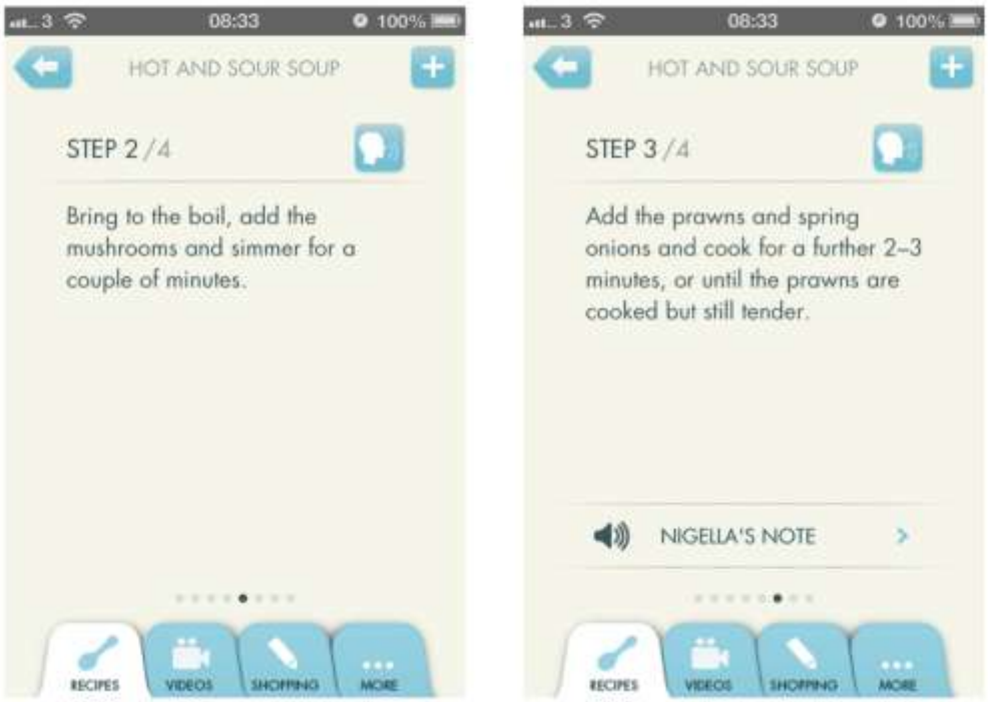

Figure 12: Single recipe step per page, Nigella Quick Collection for iPhone app

An alternative approach to holding the current place in the recipe was offered by systems that presented one step at a time, filling the whole display. Figure 11 shows how this was implemented in *Panavi* (Uriu et al., 2012). The cook can see only the current step and the previous and later steps are off the screen. A similar approach was taken by *VERA* (Tee et al., 2005) and *CounterActive* (Ju et al., 2001). Presenting a single instruction removes distraction and potential confusion and provides more screen estate to display an instruction at a larger size making it readable across a kitchen. Figure 12 shows an example of how the design is used in contemporary recipe applications for the small screen of mobile phones[3]. In isolating individual recipe instructions, the designers assumed that each instruction could stand alone but as none evaluated their designs against a traditionally formatted recipe it is not clear if being able to see the other instructions, i.e. the context, is important to cooks.

Another feature seen in several of the recipe systems was that instructions were located at the place where the task would be performed. In *CounterActive* (Ju et al., 2001) the recipe instructions were projected onto the work surface near where the cook was preparing the dish. In the *Kitchen of the Future* (Siio et al., 2007) and *PersonalChef* (Mennicken et al., 2010) multiple displays were placed around the kitchen to provide instructions where the particular work happened. In contrast traditional recipes are presented on a single sheet of paper or cookbook which remains in a single place in the kitchen. Locating the instructions around the kitchen has the potential to reduce the cognitive load on the cook because they do not need to remember the instructions between reading and reaching the place to perform the task however as no comparative evaluations were performed the benefit is unexamined.

A final feature noted in the interactive recipe systems was providing a hands-free interaction. The motivation for this is clear, the kitchen can be a messy and sticky environment unsuited to interactive hardware such as laptops. *CounterActive* (Ju et al., 2001) used an electric sensing field in the work surface which registered taps on the surface so the cook did not need to touch a

[3] Nigella Quick Collection for iPhone http://www.randomhouse.co.uk/apps

keyboard. *eyeCOOK* (Bradbury et al., 2003a) used gaze and voice recognition to enable the cook to change modes by looking and issuing voice commands. The designers of *PersonalChef* (Mennicken et al., 2010) were motivated to reduce concerns about using technology in the kitchen, however they did not report evaluation results. These interactive modes are being introduced to consumer recipe applications, for example CulinaryPal[4] which promises voice controlled recipes, however, while the need for hands free interaction makes intuitive sense in designing for the kitchen, none of the papers explored the concerns that cooks have about technology and what impact their design solution would have on the cook's work in the kitchen.

2.3.8 Structure of recipe content in interactive recipe systems

Although the recipe structures and organisation of information within were seldom discussed in the descriptions of the interactive recipe systems introduced above, most of the systems were illustrated with screen shots so it was possible to identify some features of the recipe structure and identify where these differed from the traditional structure of recipes.

A key difference between recipe instructions in interactive recipe systems such as *PersonalChef* (Mennicken et al., 2010) and *Panavi* (Uriu et at., 2012) and those in traditionally formatted recipes was the inclusion of ingredient quantities in the text of method instructions. Figure 9 shows how ingredient quantities were shown in the method instructions of *PersonalChef*, calling for 100g of ricotta and 40g of Parmesan in the second from final visible step. Similarly Figure 11 shows a recipe instruction in *Panavi* calling for 1 1/3 tablespoons of salt and 70g of pasta. *CounterActive* (Ju et al., 2001) and *VERA* (Tee et al., 2005) did not include the ingredient quantity in the text of the recipe instruction but, as shown in Figure 6 they did include the ingredient quantities for the ingredients in the step on the same page.

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[4] http://www.yizri.com/products/voicesee-culinary-pal/

Complete and detailed instructions are critical to successful completion of tasks (Eiriksdottir, 2011). By including the ingredient quantities, the designers not only made the instructions complete but also removed the need to switch attention to an ingredient list thus reducing the cognitive load on the cooks (Ganier, 2004). It is likely, therefore, that including ingredient quantities in method instruction steps was a factor in the success of interactive recipes system, however as none performed comparative evaluations the value of this design feature is unknown.

2.3.9 Linguistic content and style of recipes

Only one paper (Uriu et al, 2012) provided the wording of the recipe used in the system so for the majority of systems it is not known what style of writing was used. The text of recipes for the same dish may vary considerably and this may affect the cook and their ability to successfully complete the recipe. Considering the two recipes shown earlier for tomato sauce, Figure 1 and Figure 2, they illustrate different ways of describing the same task. MacDonald's recipe for Tomato sauce starts "In a medium saucepan, heat the oil and *fry* the onion for 6-7 minutes". Novelli's recipe describes the (almost identical) task "Heat the olive oil in a large ovenproof pan, add the onions, shallots, thyme and bay leaves, and *sweat until nicely softened*, about 8 minutes." The latter uses more technical culinary language ("sweat" rather than "fry") and introduces an evaluation clause for the cook to compare the state of the onions against – "until nicely softened".

An evaluation clause invites the cook to draw on some prior experience to evaluate the state of the materials they are working on, for example, "like rolled oats", "desired thickness", "until nicely softened". The evaluations are not absolute, they are scalar and depend on prior experience to make sense. Cotter (1992) found the key difference between the recipes for the same dish presented in different cookbooks was in the style and use of these evaluation clauses. As a consequence if the recipe used in the interactive recipe systems was written for a different target audience than the cooks who were reading it they may find the recipe “simply cannot be understood” (p58). Few of the designers of interactive recipe systems provided the wording of their recipes (an exception was Uriu et al. 2012), and none reported testing their recipe wording with cooks before integrating them into their systems.

2.3.10 Evaluations of interactive recipe systems

Considering the design motivations of the interactive recipe systems and the different presentation features designed to achieve these, few of the system authors performed evaluations to support their claims of system success. For example Hamada et al. claimed *HappyCooking* would enable cooks to prepare two recipes in optimal time but made no measures of timing or compared the results with cooks generating their own plan from two paper recipes.

Further, where evaluations were performed, the factors potentially contributing to successful implementation were not isolated for evaluation. For example Mennicken et al (2010) integrated the displays of *PersonalChef* into the work surface and behind the stove. This was important to “keep the distance between user and system minimal” (p3405) and reduce the apparent complexity of the technology. The recipe instructions were presented on the work surface display (see Figure 9) in a column. The current step was highlighted and associated with images of utensils and ingredients used in the step. Considering these two aspects of their system, i.e. the user interface and the embedded nature and location of displays, the researchers did not evaluate how either factor may contribute to the effectiveness of the system.

None of the systems described above presented recipe instructions in the traditional recipe format as described in section 2.2.1. The systems presented recipes with different structures and organisations of information as described in section 2.3.8. None, however, discussed how their recipe design differed from the traditional format or evaluated the effect of their recipe design in isolation from the user interface.

Considering the design of evaluations, only three used experimental designs to enable researchers to draw conclusions of the success of their systems in comparison with cooks using a traditional formatted recipe. Mennicken et al (2010) used a repeated measures design comparing use of their system against a paper recipe and a TV show but did not report results from conditions not using their system.

2.3.11 Addressing the assumptions in instruction design of recipes

In the interactive recipe systems introduced above, the researchers assumed that recipes are familiar and known and that changes made to their informational organisation, structure or presentation did not require description. Lacking such descriptions of key materials (recipes) and lacking evaluations of systems limits the research contribution of this work because the results cannot be built upon or generalised from. It would be useful for the design of interactive recipe systems for future research to investigate the effect of different recipe structures, information organisation and presentation on the success and user experience of the cook preparing a recipe.

2.4 Interactive recipe systems and cooks' problems

2.4.1 Assumptions of cooks' problems

Considering the design motivations of interactive recipe systems, most refer to a problem encountered by cooks, for example distraction, lack of knowledge, need for efficiency. None, however, cite empirical research of cooks that described how such problems manifest with cooks. This gap in knowledge was noted in 2002 by (Bell & Kaye, 2002) and has not yet been addressed. In their "Kitchen Manifesto", Bell and Kaye briefly report ethnographic studies of how families use kitchens in several European countries. They observed that food, cooking and the use of kitchens were inextricably intertwined with day-to-day family life and interactions with food were critical in creating "moments you spend with people you love" (p26). Considering this understanding of the human nature of food and family, they appraise the nature of kitchen technologies proposed to date and found that the "notion of food and cooking as an expression of love and attachment sits very uncomfortably with in the current world of smart houses and even smarter kitchens" (p26). They argue if technologists are to make positive interventions in the domestic kitchen they should "better understand what people are already doing in their domestic spaces and design around those activities" (p58) however none of the systems described earlier in the chapter cite this type of research.

Some of the assumed cooks' problems are identified by Grimes and Harper (2008). They analysed the design motivations of interactive recipe systems and other food-related interactive systems and argued these systems were designed to be "corrective technology" (p470), i.e. to fix the failings in human cooks. Grimes and Harper argued that the earlier researchers, by focusing on such problems as inefficiency, inexperience, distraction and lack of nutritional knowledge, made implicit assumptions that an ideal way of cooking exists and that cooks would desire it. They did not distinguish, however, that inefficiency or inexperience were in fact assumptions of cooks' problems and were not backed up by empirical studies. Further when Grimes and Harper argued that future researchers should turn their focus to designs of "celebratory technology" they inadvertently drew a line under the research without evaluating its success.

Grimes and Harper reviewed the literature from the perspective of cooks' problems, however they made no comment about target cooks for whom the systems were designed. This reflects the lack of attention to target users in the literature on interactive recipe systems. For example, Hamada et al. (2005) and Ju et al. (2001) make no comment about their target users and although the preliminary studies by Mennicken et al. (2010) were with "hobby chefs" the demographics of target users of *PersonalChef* were not discussed and hobby chefs were not recruited for the evaluation. It is not clear if, for the purposes of design, cooks can be treated as a single demographic or distinguished on a single dimension of experience. Short (2003) highlighted that cooks' skills are multidimensional and their activities, for example whether they choose to prepare meals from raw or use convenience foods are situational rather than skills based. It may be useful for designers to investigate different profiles of cooks (see for example Blake et al. 2008; Naccarato and LeBesco, 2012) in order to target designs for different patterns of cooking.

A number of assumptions of cooks' problems were apparent in the design motivations and goals of interactive recipe systems seen in the literature. They include dealing with distraction in the kitchen (e.g. Tran et al., 2005), efficient organisation of tasks (e.g. Hamada et al., 2005), confidence (e.g. Mennicken et al., 2010), lack of knowledge, for example about nutrition (e.g. Chi, Chen, Chu, & Chen, 2007) and the underlying assumption that cooks desire to perfectly replicate a recipe in their kitchen (e.g. Uriu et al., 2012). In the sections below I examine the assumptions made about cooks' problems in these interactive recipe systems.

2.4.2 Distraction: Cook's Collage

Taking interruptions as a fact of life in the family kitchen, *Cook's Collage* (Tran et al., 2005) was designed to provide an external memory for the cook, solving the problem of "remembering which ingredients have been added and how much of each has been added" (p15) so the cook can easily recover their place after an interruption. From the cook's perspective the system comprised a video camera to capture their activity and a tablet display on the wall that displayed 6 snapshots from the video stream of cooks' activities, each snapshot representing a different ingredient being added to the mixture. If the recipe required several measures of an ingredient to be added, for example 4 tablespoons of sugar, the tablet displayed the count of measures, i.e. tablespoons, that had been added. As the prototype was developed to test the benefits of external memory in the kitchen rather than technology, the actual processing of recognising ingredients and counting measures was performed by a "Wizard of Oz" human in another room.

Several evaluations of the system were conducted to explore how cooks might use the system as an external memory support to help them deal with different forms of interruptions and levels of cognitive demand. In one evaluation, participants prepared a fruit punch recipe while performing a monitoring task and or being interrupted (Tran, Mynatt, & Calcaterra, 2007). In another they made the fruit punch while learning the numbers 1-10 in Chinese or Vietnamese and were tested later on their recall (Tran et al., 2005). In each case evaluations were repeated measures designs, the cook prepared one recipe with and one recipe without support from *Cook's Collage*. The order of presentation had a significant effect on how the cooks used the system: those that prepared their first recipe without the support of *Cook's Collage* were more active in using *Cook's Collage* as a support tool when they prepared their second recipe that those who had *Cook's Collage* available for use with their first recipe.

The evaluation studies were designed to push the cooks to make errors. Cooks were provided with a limited set of measuring spoons, for example a ½ cup and a ¼ teaspoon measure and the recipes called for large quantities such as 6 ½ cups lemonade. As a consequence, cooks had to calculate they needed 13 measures of lemonade and had to count them as they measured. It is not clear how the results would generalise to everyday cooking where cooks have access to a wider range of measuring spoons.

2.4.3 Lack of knowledge: Nutrition-Aware kitchen

The Nutrition-Aware kitchen (Chi et al., 2007) was designed to support experienced cooks who were happy to cook "without following any recipes" (Chi, Chen, Chu, & Lo, 2008, p. 117) or using scales, but were unsure of the calorific content of the meals they produced. The findings of a contextual inquiry study with four cooks suggested that cooks wanted to have more nutritional information but did not have the time to seek it out and relate it to their cooking.

The system used weigh scales built into the various surfaces of the kitchen to measure the weight of ingredients as they were combined during the cooking process. This weight was used, with standard nutrition tables, to calculate the calorific content of the mixture at any time during the cooking process. This current calorie content was displayed alongside a recommended calorie count for the meal, calculated from basic metabolic rates for the diners.

The system was evaluated by three cooks with at least five years experience cooking for their family. They attended five cooking sessions over the period of a week, preparing the same family dinner on each occasion. In the first two cooking sessions the cooks prepared the meal without the support of the Nutrition-Aware system to provide a baseline calorie count for the meal. In the subsequent three cooking sessions the cooks prepared their meals with the Nutrition-Aware system. The system was a success. The cooks prepared meals with lower mean calorie count when they used the system. They did this by altering their behaviour in response to system feedback, reducing the amount of oil, condensed soup or meat they added to their dishes. In post-cooking interview cooks said they were previously unaware of the high calorie content of these ingredients and would now apply stricter controls on how much they added to their cooking.

Given the success of the system in this short term study, it would be useful for future research to investigate the longer term effects of learning about calorie counts of everyday cooking and to investigate how it might be incorporated with other kitchen based systems (e.g. Wagner, Geleijnse, & van Halteren, 2011) that aim to support healthy cooking in the home.

2.4.4 Perfect reproduction of a recipe: Panavi

Panavi (Uriu et al. 2012), described in section 2.3.6 above was designed to help cooks prepare Pasta Carbonara perfectly, i.e. for cooks who have problems preparing a recipe perfectly when following a textual recipe. Although the system was only partially successful in this – the cooks who evaluated the system prepared dishes described as "slightly baked" (p135) or "slightly sloppy" (p137) – the problems that cooks' experienced while preparing the recipe were described only in relation to them using the system. No study was performed to evaluate the problems the cooks had preparing Pasta Carbonara without the support of *Panavi*, and the system was designed with the inherent assumption that cooks would desire to prepare the dish “perfectly”. Some of the cooks who took part in the evaluation indicated they would enjoy a second chance to improve their success but it is not clear how this would generalise to other recipes.

Another system conceived to support perfect replication was described as the *Semantic Cookbook* (Schneider, 2007). In this conceptual kitchen – no prototype was built – every device, utensil and food stuff would be instrumented to measure weight, temperature, motion, location etc. A cook could then prepare a dish and have their every action recorded. The subsequent recording could be played back in remote kitchen that would first check that sufficient of all the ingredients were available, and then during the preparation of the recipe, monitor the cook to ensure they were preparing exactly the same way as the recorded recipe.

Wharton (2010) suggests that cooks turn to recipes for entertainment and inspiration rather than procedural instructions to follow to the letter. Lacking empirical research it is not clear if cooks desire a “perfect recipe” outcome every, or indeed any, time they cook from a recipe.

2.4.5 Efficient organisation of tasks: HappyCooking

Considering the problems of task organisation *HappyCooking* (Hamada et al. 2005) was designed to calculate the optimal task plan for a cook to prepare two or more recipes in parallel in the shortest time with each recipe finishing at the same time. The system was described in section 2.3.3 above. The problem sounds very familiar and is probably played out in many homes when preparing the evening meal. The authors did not investigate or cite any research, (e.g. Beck, 2007), of how cooks prepare meals and manage the problem without system support. Further, no measures were taken in the evaluation to demonstrate that cooks who used the system were better organised than those preparing the same recipes without the system.

2.4.6 Confidence: PersonalChef

Confidence is a problem for both novice and experienced cooks (Stead et al., 2004) and systems have been proposed to support both levels. The *Not Enough Cooks* (de Runa, Harpring, Rafiuddin, & Zhu, 2010) system concept proposed a design share cooking videos among friends to support the more novice cooks. *PersonalChef* (Mennicken et al. 2010) was designed to increase the confidence of “hobby chefs” when preparing a dish they were unfamiliar with. However, neither Mennicken et al. or de Runa et al. investigated how the problem of cooks’ confidence manifested when cooks followed traditional recipes and no measures of confidence were taken during the evaluation of the system (Mennicken et al., 2010)

2.4.7 Sharing recipes among friends and family: Living Cookbook

In contrast to the systems that focused on negative skills, this system addressed the problem of sharing recipes with friends, taking the approach that a richer experience would enhance the information shared. The *Living Cookbook* (Terrenghi et al., 2007) was designed for cooks to share recipes and cooking knowledge among friends and family to “preserve cultural and social roots …and stimulate cultural and generational fertilisation” (Terrenghi, 2006, p. 43). Further, they argued that if friends or family members recorded themselves making a recipe including personal tips and tricks this would add an “emotional quality of content…[that] promises to affect motivation and engagement” (Terrenghi, 2006, p. 43) of learner cooks and thus transfer knowledge more effectively. However, no research was cited that supported these assumptions of what cooks would want.

The *Living Cookbook* system comprised a tablet PC installed on a kitchen cupboard, a video camera to record the action and a projector to replay the video on the kitchen wall. During recording, the cook, playing the role of an instructor, created an entry for the recipe on the tablet, using simple drag and drop of images to construct an ingredient list and then provided the instructions as a performance captured by the video camera. Later, a learner cook could then browse the available recipes on the tablet and choose to playback a video and follow the performance at their own pace.

The system was evaluated in two phases. In the first, four members of the design and development team took part. Two created recipes and two played them back and cooked along. In the second, four people from outside the lab performed a cognitive walkthrough evaluation through several tasks on the system. No measures of cooks' skills, timing, or cooking success were taken. Each evaluation session ended with a group meal, where participants were encouraged to feedback their impressions of the system with the researchers.

The evaluations highlighted some limitations of the physical implementation of *Living Cookbook*, for example, a single video camera was insufficient to record all the action of cooking and cooks often misplaced the tablet pen among the cooking utensils and ingredients. They also highlighted how the cooks' views of the purpose of the system differed from those of the designers. The instructor cooks wanted functionality to check their own recordings before committing them to the system and learner cooks wanted more precise information on how to perform techniques.

Grimes and Harper (2008) highlighted the *Living Cookbook* as an exception to the trend of "corrective technology" (p470) approaches to interactive human-food systems. They valued it because it was seen to offer a new way of engaging with cooking. The evaluations, limited as they were, showed that the cooks took a different view. They enjoyed participating in the cooking sessions but were concerned about the cooking performances and sought more control over their recordings and precision in the instructions. The cooks wanted a more detailed system for capturing and playing back recipes. The design assumptions were that cooks would engage with the emotional aspects of personal communication but the researchers failed to test their assumptions of what cooks want or need from a system to capture and play back recipes.

2.4.8 Addressing the assumptions in cooks' problems

Considering the cooks' problems that interactive recipe systems were designed to solve, few researchers investigated how cooks experienced the problems and what strategies they used to solve them. Overall the systems took a negative view on the abilities and motivations of cooks that required "corrective technology" to overcome (Grimes and Harper, 2007) but their major failing lies not in the corrective nature of their systems but in the failure to investigate the problems and evaluate their systems success in helping cooks overcome them. Lacking this attention to human aspects of design, one of the core aspects of UCD, limits the contribution of this research to the discipline. It would be useful for future research into the design of interactive recipe systems to investigate the problems that cooks face when cooking with recipes and evaluate potential solutions.

2.5 Interactive systems for other human-food interactions

The systems above focus on supporting the practice of cooking. Before the cook gets to the kitchen, however, the raw ingredients must be purchased and decisions made over what to eat. These aspects of human-food interaction have also attracted researchers who have investigated ways to support cooks in shopping for healthy and local foods and planning healthy meals. Many of these systems have been designed for students or young families who lack skills and experience to cook from scratch and are therefore at risk of poor diet quality (Larson et al., 2006).

2.5.1 Shopping

A number of shopping support systems have been proposed to help cooks make better choices when shopping in order to support healthier diets, or purchases of more local and seasonal foods. Each system relies upon access to a range of information about available foods stuffs, including provenance, seasonality, nutritional values and where available. They further rely upon access to purchase history information – what the cook has previously bought. This range of data may be stored by some of the major supermarkets in recent years, it is not clear if such information would be available for third party systems to access.

In an early system, proposed before supermarkets had reward schemes to track consumers' individual shopping habits, Mankoff, Hsieh, Hung, Lee, & Nitao, 2002 attempted to estimate a household's weekly food consumption based upon their supermarket receipts in order to make recommendations for shopping in subsequent weeks. The researchers found their estimates were out by a factor of two. One reason for this large error was technical – the receipts of the time (2002) did not contain much information and the researcher had to estimate the quantity purchased from the price listed. The other reason was due to the underlying assumption that food purchased was eaten and all food eaten was purchased in the same time period.

More recent shopping support systems such as *Health View* (Beach, Briggs, Shahrani, & Elliott, 2006) and *Food Information Net* (Rong, Ochoa, Ritter, & Brown, 2006) systems were designed for students and based on assumptions that shopping is habitual and people do not have the time or information to explore to find more healthful options than their habitual purchases. The systems provided cooks with information about local and healthy options based on previous purchase records. *Health View* made similar assumptions to those made by Mankoff et al. (2002), linking purchase behaviour to consumption. Other researchers, however, have found that for this demographic, even purchases made just before eating could not be related to consumption (Chand, Gonzalez, Missig, Phanichphant, & Sun, 2006).

Other shopping support systems have focused on supporting purchases of local and sustainable foods. *Edible Earth* (Bohner, D'Adamo, Faeth, Kaplan, & Marsh, 2009) proposed a web and smart phone application to guide students to where they could buy locally produced and seasonal foods and provided recipes to make from them. *Local Buy* (Li, Hathaipontaluk, & Luo, 2009) described a web application designed to support a local infrastructure to bring together local food producers and consumers at local “hubs”. In setting the design goals, the designers of these systems made assumptions about the availability of information about food stuffs and about the preferences and motivations of people to seek out and purchase local, sustainable or healthier food stuffs. It is not clear if these assumptions were supported by the young demographic the systems were targeted at and if they would generalise to a wider population.

2.5.2 Meal planning

Between food shopping and cooking is the task of meal planning. Aberg (2009) proposed a meal planning system that was designed to support people who wanted to plan healthy meals but lacked the time and nutritional knowledge to do so. Unlike the shopping systems above, it was designed to be universally accessible and therefore relevant to a wide demographic.

The system calculated a four day meal plan, covering all meals, based on food preferences and dietary constraints of the user. Two usability evaluations were performed; the first to investigate ease of use, the second to investigate perceived usefulness. In the first evaluation, 10 people over 70 (eight women, two men) were asked to perform six tasks with the system, including input of personal preferences and creating several meal plans for different social events. Many of the participants had problems with the user interface but as only three of the participants were involved in meal planning at home it was not possible to evaluate the usefulness of the system with these testers.

In the second evaluation, eight male computer science post-graduates were asked to perform two tasks with the system and rate their experience in three ways; (a) overall usefulness, (b) content of meal plans and (c) process to get meal plans. Both tasks asked the participants to iteratively change their personal settings and request new meal plan construction until they were presented with an acceptable meal plan. It was only after the second evaluation that participants were asked if they would use the system. While most said it was easier to use than planning from a cookbook, no user research was reported exploring how people plan meals and how their nutritional concerns are expressed through this. Lacking this user research Aberg was unable to recruit participants experienced with meal planning tasks and evaluate the system against the success of their current meal planning activities.

2.6 Chapter summary

The literature review reported in this chapter shows that systems to support human-food interaction and in particular those to support cooking have introduced a number of novel design concepts. But the researchers have failed to support their novel designs with user research and evaluations that would enable future researchers to build on their results.

Few researchers engaged empirical research to understand how people perform tasks around food and the problems they encounter. In focusing most of the systems towards supporting younger people, researchers have also limited the ability to generalise the potential benefits of their systems. Further, researchers have failed to evaluate their systems, as a result the novel ideas remain untested for usability and usefulness. With specific regards to interactive recipe systems, researchers have not identified that recipes are sets of instructions and as such, the design of instructions may be key to the success of their systems. This gap suggests that guidelines from instruction design research may be called on to help designers understand the impact of instruction design and to inform the better design of recipe instructions used in interactive recipe systems.

Chapter 3 Focus groups on older adults' meal planning, shopping and cooking behaviours

3.1 Introduction

Food is part of every person's life all through our lives, yet most food related research within HCI has focused on the needs of younger adults, and how to support their perceived lack of knowledge and skills (Grimes & Harper, 2008). Little research has explored if there is a need for such support beyond this demographic and few of the proposed systems have been evaluated by the wider population. Drawing on a limited population in this way limits the generalizability of the research (Dickinson, Arnott, & Prior, 2007) and also misses the potential to discover and develop new ideas (Eisma et al., 2003). In this study I investigate the meal planning, shopping and cooking habits of a group of older adults to discover if the assumptions made and design goals of HCI food related research generalises to this group.

3.1.1 Meal planning

Considering meal planning systems, most share a design goal to support young adults and young families. For example, *SuChef* (Palay & Newman, 2009) gathered everyday recipes from a loose social circle and shared them in a prototype recipe board to encourage a wider variety of everyday meals and *Your dinner's calling* (Snyder, Zimmerman, & Forlizzi, 2007) integrated meal plans with shopping lists so that all members of a young family could contribute to the planning and adults could distribute the shopping and cooking tasks. *Edible Earth* (Bohner et al., 2009) was designed to help students both plan meals using local produce and to locate where to buy the local produce.

By contrast, Aberg (2009) created a prototype meal planning system intended to be useful and usable across all ages. The system calculated a balanced nutritional meal plan for four days of lunch and evening meal based on personal preferences and dietary restrictions. It ensured variety in the plan by preventing two consecutive meals sharing too many ingredients. In the first evaluation ten older adults (mean age 76) evaluated the accessibility of the system, however, the participants were unable to comment on the usefulness because only three of them were familiar with the task of meal planning. In the second evaluation, eight students (mean age 24) who planned and cooked their own meals evaluated the functionality. Five said meal planning was easier with the system than it would be using cookbooks but notably they were not asked if they used cookbooks in their routine meal planning activities.

Indeed there was no reference to research that supported the assumptions of this research. Do cooks plan meals for four days in advance? Do they use cookbooks or recipes in their meal planning? Do they want to prepare and eat something different for every meal? The assumptions were not tested within the study with either the students or the older adult participants so it is not clear if they were valid for the students or if they would generalise to a wider population.

3.1.2 Shopping

Systems to support shopping activities have become mainstream. The major supermarkets, in the UK at least, offer online grocery shopping and applications to recommend recipes and build shopping lists from them. Within HCI, systems have been proposed to support the shopping task with context aware trolleys (Black, Clemmensen, & Skov, 2009) and information displays on aisles (Bedi et al., 2010) but the main goals of shopping support systems has been to promote and nudge users to purchase healthier or more locally produced food stuffs (e.g, Mankoff et al., 2002; Rong et al., 2006; Yang, Hanratty, Ho, & Wei, 2009).

A common underlying assumption is that consumers perform most of their shopping in supermarkets. This is explicit in systems such as *HealthShelf* (Bedi et al., 2010) and context aware shopping trolleys (Black et al., 2009) but is also implicit in the data requirements of systems that nudge behaviour. The technical assumptions of these systems include access to a database of produce available in store(s) with information about provenance and nutritional values for each product (e.g. Bedi et al., 2010; Yang et al., 2009). In order to make personalised recommendations the systems also assume access to the users' purchase history (e.g. Beach et al., 2006; Mankoff et al., 2002). Large supermarkets maintain inventory databases and from 2014 these will incorporate provenance and nutritional data[5]. Supermarkets also store consumer purchase history. In assuming access to these types of data the systems make an underlying assumptions of user behaviour - that they perform most of their food shopping in such stores.

Considering the assumptions of systems that aim to nudge better purchasing behaviours, for example *Food Information Network* (Rong et al., 2006) and *Edible Earth* (Bohner et al., 2009), these systems assume that consumers currently lack the information necessary to make these choices and if they had the information they would be willing to make the change. Further they assume that consumers plan their shopping and thus provide data on which recommendations can be made. However, as the earlier systems were designed for a demographic of students in American universities it is not clear whether the assumptions would generalise across cultures and generations.

3.1.3 Cooking

Considering systems designed to be used in the kitchen to support cooking, the main goal has been to support cooks to prepare recipes accurately and efficiently (Grimes & Harper, 2008) and evaluations of systems, where performed, have focused on novice cooks (e.g. Ju et al., 2001; Uriu et al., 2012). Two systems were evaluated with a group including older cooks; *PersonalChef* (Mennicken et al., 2010) and *Cook's Collage* (Tran et al., 2005). Twelve cooks

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http://ec.europa.eu/food/food/labellingnutrition/foodlabelling/proposed_legislation_en.htm with mean age 35 evaluated *PersonalChef*. One of these was aged 73 but Mennicken et al. did not report detailed findings. Tran et al detailed the contrasting approach of older and younger adults using *Cook's Collage*.

The *Cook's Collage* system was a cooking memory aid, designed to help cooks maintain accuracy in their recipe preparation even when their attention was diverted by interruptions and the need to multitask in the kitchen. The system provided a snapshop of the current status of recipe presentation by showing how much of each ingredient in a recipe had been added to a mixing bowl. *Cook's Collage* was evaluated by six cooks: three younger, three older. The cooks prepared a recipe for fruit punch and their strategies and errors were observed as they were given dual tasks (for example learning to count to 10 in Cantonese) and interrupted (for example to reset an alarm).

While Tran et al. were cautious in their conclusions from this preliminary study, it is not clear if the recipes used and the way they were presented and the measures of accuracy was appropriate and representative of how cooks perform their work in the kitchen. The recipes were presented on a tablet placed at eye level on a kitchen cupboard door so cooks could not mark off ingredients as they might do if using a paper recipe. The ingredient lists included multiple quantities of small units of measure, for example 6 1/2 cups of water or 2 tsp of strawberry powder, and the cooks were provided only a limited set of measuring utensils, for example a 1/2 cup and a 1/2 tsp measure so the cooks had to count high numbers of each measure. They did not investigate if the limited range of measuring spoons and cups was different from their day-to-day experience and if so, if it affected the cooks' performance. Further, an underlying assumption of this system and that of others such as *PersonalChef* (Mennicken et al., 2010), was that cooks share a goal to prepare recipes with precision and accuracy and this assumption remains unexamined in the research.

3.1.4 Research questions

Although a few food related systems have involved older adults in the evaluation, there remain unexamined assumptions of whether the functionality is appropriate or desired by older adults. In this study I made a preliminary investigation of the meal planning, shopping and cooking habits of older adults using a focus group methodology to investigate how they perform their food related activities to see if there is a need for technological support and to find out if the existing research generalises to this group.

A supplementary research question was to investigate the problems experience with kitchen utensils in support of partner students, as I was funded from a White Rose collaboration project in which a number of researchers were interested in utensil use.

3.1.4.1 Research question for White Rose partner students

This research was funded from the White Rose Consortium of the Universities of Leeds, Sheffield and York. Three students, including myself and two partner students, were funded in a loose collaborative project. In this study a supplementary research question was introduced to gather information for my partner students to investigate the problems older adults experience with kitchen utensils.

3.2 Method

3.2.1 Participants

Fifteen participants took part in four focus groups. Table 2, Table 3 and Table 4 show the demographics of the participants. Four participants were men, 11 were women. Seven participants were aged between 60-69 years, eight were aged between 70-79 years and two were over 80 years; eight participants lived alone, seven with a spouse.

Table 2: Participants by age and gender

Gender/age	60-69	70-79	80+	Total
Male	1	2	1	**4**
Female	6	4	1	**11**
Total	**7**	**6**	**2**	**15**

Table 3: Participants by household type and gender

Gender/household type	Living alone	Living with spouse	Total
Male	1	3	**4**
Female	7	4	**11**
Total	**8**	**7**	**15**

Table 4: Participants by household type and age

Household/age	60-69	70-79	80+	Total
Living alone	4	4	0	**8**
Living with spouse	3	2	2	**7**
Total	**7**	**6**	**2**	**15**

The participants were recruited from the membership of three organisations in York: University of the Third Age (U3A), York Older People's Assembly (YOPA) and Askham Bryant Gardeners' Club. An article describing the research was printed in the bi-monthly U3A newsletter and leaflets were included with the regular mailings to the other groups. Participants were offered £10 worth of vouchers from their favourite supermarket in compensation for their time and effort.

3.2.2 Materials

A recruitment leaflet was distributed to members of YOPA and Askham Bryan Gardeners' Club. A short questionnaire about cooking and shopping habits was included in the information pack sent to participants in advance of the focus group they were due to attend. Participants were asked to complete the questionnaire and bring it with them. At the start of the focus group, participants were asked to complete an informed consent form. A copy of each of these materials can be found in Appendix 1.

3.2.3 Procedure

Prior to attendance at the focus group, participants were sent an information pack. It included a questionnaire about their cooking and shopping habits and a request to think about kitchen utensils they either loved or hated. They were asked to bring the completed questionnaire and an example of a loved utensil and a hated utensil to the focus group. Participants were requested not to bring knives.

Focus groups were held in meeting rooms in the Department of Computer Science at University of York. Participants sat around a large table and were invited to place the utensils they had brought with them onto the table. Tea and coffee and homemade cake were available throughout the session. Each focus group took no longer than 60 minutes.

At the start of each focus group I introduced myself as the researcher and introduced the goal of the research and the procedures of the session. Participants were asked to read and sign the informed consent form. A microphone was placed on the table and the session audio recorded onto a laptop.

Participants were asked a series of questions to trigger discussion about the utensils they had brought along and their meal planning, shopping and cooking activities.

- Can you tell us what utensil you have brought along that you love and tell us why you love it?
- Thinking about a meal you have cooked in the last few days, can you tell us what you made and how you made it?
- Do you plan your meals in advance?
- Can you tell us what utensil you have brought along that you do not like and tell us why you do not like it
- Do you often try new foods?
- Where do you get your inspiration for cooking?
- Where do you shop and why?
- Do you share your cooking skills?

At the end of the session I summarised the key points mentioned by the participants during the session and explained how data from the focus groups would be used within my research. Each utensil was photographed. Taxis were organised for participants that needed them.

Within two days of the focus group, a follow-up pack was sent to the participant. The pack contained a voucher for £10 for the supermarket of their choice and asked if they would be willing to take part in future research.

3.2.4 Data preparation

The audio recordings were transcribed and then analysed using topic coding (Saldana, 2009) clustered around meal planning, shopping and cooking themes.

Photographs of utensils were tagged with participant id, type of item, loved or hated status and comments made about the utensil. A summary report of utensil data was prepared and shared with White Rose collaboration partners.

3.3 Results

3.3.1 Sources of cooking knowledge and skills

To investigate sources and currency of cooking knowledge, participants were asked to indicate when they learned to cook and what they used to develop new cooking knowledge.

Table 5: When participants learned to cook

Options	Frequency (n=15)	% of participants
As a child with mother/father	9 (all women)	60
Later in life	7	47
As pupil in cookery lessons at school	6 (all women)	40
As young adult fending for self	4	27
When I started a family	3	20

Table 5 shows when participants learned to cook. They were asked to tick all the options that applied and add a comment if desired. Most participants indicated that learning to cook was not a once in a lifetime experience, for example fg3.1 said "*I took minimal school lessons. On retirement at age 60, I began to take an interest and share the work with my wife and with an eye to the future*". FG1.4 said she was "*still open to learning*".

Table 6: Sources of new cooking knowledge

Source	Frequency (n=13)	% of participants
Cookery books	13	100
Articles and recipes in magazines	11	85
Swapping recipes with friends and family	8	62
TV cooking shows	6	46
Cookery class	4	31
Articles and recipes from websites	3	23
"how to" videos on internet	0	0

Table 6 shows the sources of cooking knowledge. Two participants did not complete this section of the questionnaire so n=13. Every participant used cookery books, eleven used magazines and eight of these also swapped recipes. In this group of participants only three used websites for cooking information and knowledge.

3.3.2 Shopping habits

To investigate how participants planned and enacted their shopping they were asked where and how often they shopped and how they planned for it.

Table 7: Frequency of shopping

Frequency of shop	Frequency (n=15)	% of participants
Daily (5+ times a week)	2	13
Several times a week (2-4)	12	80
Once a week	1	
Less often	0	

Table 8: Types of shops used

Location / type of shop	Frequency (n=15)	% of participants
Supermarket	14	93
Small stores (butchers, bakers, greengrocers)	9	60
Speciality (e.g. wholefood)	7	47
Local suppliers (e.g. direct from farmers)	5	33
Markets	5	33

Table 7 shows how often participants shopped for food. Twelve (80%) shopped several times a shopped several times a week, two shopped more often and only 1 shopped only once a week. only once a week.

Table 8 shows the types of store or sources of food used by participants. Participants were asked to indicate all that were relevant. Four participants shopped exclusively at supermarkets, one never shopped at a supermarket, and the remaining 10 shopped at supermarket and 2 or more of the other food sources. The participant who shopped once a week did that shop at a supermarket.

Table 9: Planning the shop

Planning option	Frequency (n=12)	% of participants
Plan meals and make list	10	83
Buy what is on offer or appeals in the store	7	58
From memory because what you buy is the same every week	4	33

Table 9 shows the frequency of different planning activities. Participants were asked to indicate all options that were relevant. Three participants did not complete this section. Three participants said they did all three options, three planned and made spontaneous purchases and four said they planned exclusively.

Participants were also asked for comments about the shopping activities. These qualify the figures above and indicate that plans, even when made, are flexible to special offers and attractive produce seen at the store. For example, two participants indicated they start with a plan but then add or change according to food items they see;

- *I always make a list but check special offers and may change what I intended e.g. if special offer on fruit & veg, meat/fish* (fg3.4)
- *I plan and make shopping list mostly, also use memory and spontaneous purchases to some extent* (fg3.3)

One participant explained that shopping was not always intended for immediate use

- *I keep a lot of food stored so that "this week's shopping" does not necessarily represent what we will be eating immediately* (fg2.2)

One said that “*good purchases often plan the menu”* (fg1.1) and another that planning only happened “*when visitors were expected*” (fg1.5).

3.3.3 Utensils brought to the focus groups

To stimulate discussion about cooking and to gather data about problems experienced with utensils for the White Rose collaboration partners, participants were asked to talk about the utensils they had brought along.

Table 10: Utensils brought to focus groups with typical comments with frequency, f

Utensil type	Loved		Hated		Total
	f	Typical item & comment	f	Typical item & comment	f
Openers	6	*Brabantia lid opener* “it solves a problem for someone with a moderate grip who lives alone” see Figure 13	2	*Strap wrench jar opener* “useless object …I don’t think I’ve ever opened anything with it, it’s lucky it’s not in the bin” see Figure 14	**8**
Knives & other cutting devices	2	*Carbon steel knives* “my fundamental tool” [participant brought photograph along to illustrate]	4	*Herb chopper* Too fiddly to assemble, cavity for herbs is too small & washing up is difficult	**6**
Vegetable peelers	4	*Cheap metal peeler* “very functional” “I lose them regularly by throwing them out with the peelings” see Figure 15	2	*Plastic peeler* “I can’t get used to it” see Figure 16	**6**
Stick blender	4	“chops onions and mix all kinds of things…so easy to wash… use for soups and sauces” A rescue device	1	“very good for throwing stuff out of the pan”	**5**
Mixing tools	5	*Balloon whisk* “I couldn’t do without this”	0		**5**
Misc	3	*Homemade damson pricker* “It looks terribly unhygienic but it’s very effective”	3	*Garlic crusher* “there’s nothing mechanically wrong with this, it’s just that the garlic gets stuck in the little holes in there”	**6**
Total	**24**		**12**		**36**

Figure 13: Brabanta lid opener (loved)

Figure 14: Strap wrench jar opener (hated)

Figure 15: Cheap metal peeler (loved)

Figure 16: Plastic peeler (hated)

Table 10 shows some of the items brought along to the focus group and typical comments made about them. Some participants brought several items so the total count was more than 30. Figure 13 and Figure 15 show two loved utensils. Figure 14 and Figure 16 show two hated utensils. Lengthy discussion ensued about the shape and usability of vegetable peelers and it was clear that cooks either loved or hated the style illustrated here in figures 15 and 16.

A full report of the utensils and the comments about them was compiled and provided for my White Rose colleagues who used it to inform their later research.

3.3.4 Themes emergent from discussion

To investigate the assumptions made in the literature of meal planning, shopping and cooking activities, the focus group transcripts were analysed and comments relating to each area organised by topic.

Table 11: Meal planning themes and typical comments

Theme	Typical comments
Planned meals	• Three day routine "roast pork on Sunday which means on Monday we have cold pork…and shepherd's or in this case swineherd's pie on Tuesday" fg1.1 • "yeah, I would have an idea of what I'm doing everyday basically, it doesn't always work out like that" fg1.2 • "I like to have a mental plan. It doesn't always fall on the same day because something might come up" fg1.3
Spontaneous meals	• "I didn't know what I was going to eat until I walked into Morrison's, there is a fish counter and they had nice looking salmon and I thought I haven't had salmon for a long time" fg3.2
Variety (adapting left overs or storing extra portions for later)	• "I think when you use leftovers then you get a different meal a day after which is fascinating, soup if all else fails" fg2.2 • "I live alone and I cannot cook for one, I can't do it, it doesn't work…so normally I make at least two and sometimes four and it goes in the freezer" fg1.4
Lack of variety	• "Almost every week the family from York will come so you know I cook something more then and I'm eating leftovers for a few days" fg4.2 • "we do sometimes eat the same thing two days running, very happily, I don't mind at all" fg2.2 • "I always make a lot of everything I make, sometimes it's a pain actually. I'm not good at

	little portions of things, it seems wasteful… waste of resources to cook just a little bit" fg2.1

Table 11 shows there is some support for the assumption that cooks plan meals for several days in advance but the comments suggest that when cooks make these plans they are neither fixed nor in detail. The comments suggest there is little support for the assumption that cooks want variety between meals. Variety where it exists is created by adapting left overs and storing extra portions for a later date.

Table 12: Shopping themes and typical comments

Theme	Typical comments
Shops at supermarkets	• "I bought some chops in Tesco on offer, probably in the reduced to clear and I think there were six" fg1.5
Shops at smaller stores	• "the shops are literally 100m away...now I go to the supermarket maybe once in 2-3 weeks to buy something exotic" fg3.1 • Only buys from a particular butcher "when you don't eat much meat you might as well eat the best you can afford" fg3.3 • "I'm still mobile and I have a vehicle, I can shop wherever I fancy and I do" fg4.3
Plans shopping	• Tuesday "the fish van comes from Grimsby with most gorgeous fish so am tempted to buy for Tuesday, Wednesday, Thursday and go shopping again on Friday"... plans appointments in town on Friday so can go to particular butcher fg3.3 • Participant uses a bus on hourly schedule so she "look[s] online before I go to see what is on offer" to plan the route around Tesco fg3.4
Shops spontaneously	• "I find that if there is something on offer and you've already planning in your mind what you're having then you can still buy the offer and put it in the freezer or make the dish and put in the freezer" fg1.4 • There are "two good greengrocers, a butchers and a deli so as I walk along I buy what looks good and fresh on the day" fg4.2

Table 12 shows there is little support for the assumption that cooks perform most of their shopping at large stores who store data about produce provenance, nutrition, and of customers' purchase histories. There is some support for the assumption that cooks plan their shopping but the comments also suggest that even when a shopping list is planned they would respond spontaneously to a special offer.

Table 13: Cooking themes and typical comments

Theme	Typical comments
Cooking responds to available ingredients	• "I make a lot of soups so I'm starting with fresh vegetables and [vegetable peeler] is equally good for parsnips, carrots or sweet potato"- lunch is usually soup, bread and cheese fg3.1 • "I make whatever I've got in the fridge, when things are past their best I'll make soup" fg4.2 • A large chicken on Sunday is used again for cold chicken with bubble and squeak on Monday, and chicken risotto on Wednesday fg1.5 • Brought up to be economical "I use everything, never throw anything away. Our hens would starve if they had to manage on what we throw out" fg2.2
Adventurous cooking	• "since I've been on my own I've been experimenting more because I think that it doesn't matter, I'm only cooking for me" fg3.4 • "I have a wok and being much travelled, that is living overseas, then I eat what other people think is exotic" fg4.3
Recipe use (or non-use!)	• "there's a whole lot of useless, well shall we say, unnecessary ingredients, tamarind powder, where am I going to get that? So I cross it off" fg3.1 • Cooking from recipes is tedious "I think people who make cakes, it has to be just so and I'm not a just so sort of person" fg4.2

Table 13 shows there was little support for assumption that cooks were interested in accurate preparation of recipes. Few cooks used recipes in their cooking and when they did they adapted them to suit the available ingredients.

3.4 Discussion

Fifteen participants, aged from 60 to over 80, took part in four focus groups to investigate the meal planning, shopping and cooking activities of older adults. The focus groups were transcribed and then analysed to investigate patterns of food related activities and find out if the assumptions of earlier food related systems generalised to the wider population including this group of people.

3.4.1 Meal planning

Considering the assumptions in the design of meal planning systems (e.g. Aberg, 2009) that (a) cooks plan 3 to 4 days in advance, (b) they want variety between meals and (c) they use cookbooks to support meal planning activities, there is little overall support found from these participants. Participants did plan meals but only one participant made solid plans and knew "exactly what I am going to be eating for the next week" fg3.3. Other participants described a more fluid planning process of a mental plan, for example "I would have an idea of what I'm doing every day basically but it doesn't always work out like that" fg1.2. Shopping sometimes caused plans to change when participants saw an appealing display of produce or a special offer, for example fg1.4 said "I find that if there is something on offer and you've already planning in your mind what you're having then you can still buy the offer and put it in the freezer or make the dish and put in the freezer".

Participants did not actively seek out great variety between meals. Indeed in discussing their cooking activities and use of left overs they readily accepted they would eat the same or something similar for several days running for example fg2.2 said "we do sometimes eat the same thing two days running very happily, I don't mind at all". Leftovers were an accepted form of creating a meal as fg2.2 said "I think when you use leftovers then you get a different meal a day after which is fascinating" and sometimes deliberately made because of the difficulty of cooking smaller portions.

Those participants who planned their meals did not use cookbooks to do support this task. Their plans were based on template meals whose specifics adapted to the available ingredients, for example, fg1.1 planned three days meals based on his Sunday roast "roast pork on Sunday which means on Monday we have cold pork… and Shepherd's or this case Swineherd's pie on Tuesday".

3.4.2 Shopping

Considering the assumptions in the design of shopping support systems that (a) shoppers did most of their shopping in supermarkets and (b) they want to purchase local and healthier foods but lack the information to do so, there was mixed support from this group of participants.

All bar one of the participants shopped in supermarkets but only four shopped exclusively at supermarkets. The majority of participants (67%) bought some food in supermarkets and specific foods in small stores such as butchers, greengrocers, bakers, fishmongers and markets. For example fg4.2 wanders down her local highstreet on which there are "two good greengrocers, a butchers and a deli so as I walk along I buy what looks good and fresh on the day" and fg3.1 only visits the supermarket "maybe once in 2-3 weeks to buy something exotic". This spread of shopping across many types of stores and markets runs counter to assumptions that consumers make the majority of food purchases at supermarkets. For systems that require a database of products with provenance and nutritional information, this shopping behaviour presents technical challenges because it is unlikely that small stores and market stall holders would have this data available. Overall it suggests that these participants' shopping activities are more complex than has been assumed in the literature.

Considering the assumption that users need to be nudged to buy more and healthier foods, this group of participants were already actively doing this so had little need for additional support. For example fg3.3 only buys meat from a particular butcher and said "when you don't eat much meat you might as well eat the best you can afford". Similarly fg4.2 spoke of her local "two good greengrocers, a butchers and a deli, so as I walk along I buy what looks good and fresh on the day". From the discussions at these focus groups, it was clear this participant group had knowledge of good food and where to get it and did not need any further support in this area.

3.4.3 Cooking

Considering the assumption underlying cooking support systems that cooks strive for accurate preparation of recipes there was little evidence that this assumption held for this group of participants. Participants in this study spoke of their preferred way of cooking as "things you can just throw together, like soups and bread, things you don't have to worry too much about…" fg4.2.

The participants in this study were all interested in browsing recipes from cookbooks, and more than half read food related articles in magazines and swapped recipes with friends and family but they did not often cook from recipes and when they did, they did not follow them to the letter. For example fg3.4 spoke of experimenting with new dishes but was not concerned if they did not turn out perfectly, "I think that it doesn't matter, I'm only cooking for me". Fg3.1 articulated an opinion agreed by others "there's a whole lot of useless, well shall we say, unnecessary ingredients. Tamarind powder, where am I going to get that? So I cross it off". While it was not possible in the format of a focus group to explore the detail of how these participants cooked, it was clear their attitude to recipes and cooking did not value accurate and precise reproduction of a recipe in contrast to the goals of cooking support systems in the literature.

3.4.4 Limitations of the study

The participants in this study were recruited via the U3A, YOPA and the Askham Bryan Gardeners Club in York. They were self selecting in response to a call from a leaflet or article so their interest in food and cooking could not be generalised to the wider population of older adults, many of whom may consider cooking to be more of a chore than a pleasure.

The primary goal of the focus groups for this research project was to investigate the food related activities of older adults, however approximately 20 minutes (33%) of the duration of the focus group was spend discussing utensils in support of the secondary goal to gather data for my collaborative research partners. The discussion of utensils produced results for other researchers in the collaborative project but little that could be directly applied to the goals of this study.

Considering the methodology, focus groups are useful to delve into the attitudes and feelings of people (Greenbaum, 1999) but it can be challenging to produce reliable results because participants are not matched across focus groups and questions are not asked and answered in a controlled structure. In addition, validity of the data may be challenged because participants may phrase their answers to fit what they think the researcher wants to hear. Several participants were keen to distance themselves from what they saw as unhealthy practices of TV chefs, for example fg2.2 said "I am amazed how much fresh cream these chefs on the television use these days, just when we are all being told to cut down on that sort of thing". In the ensuing discussion, several participants made a point of saying they ate healthier options such as low fat crème freche or soya cream. In this, and a similar discussion in one of the other focus groups, the moral dimensions associated with food and the group dynamics of the setting may have affected the input from several of the participants and therefore on the overall results of the study.

3.4.5 Conclusion

The findings indicate that assumptions made for and design goals of earlier HCI food related systems do not hold for this group of adults. Participants do not plan their meals for several days and then stick firmly to this plan. They are more flexible with their daily lives and with food they see when they go shopping. These participants were knowledgeable and enthusiastic about food and did not need additional support for where to find and purchase local produce. In cooking the participants described a combination of habitual patterns and flexibility in producing individual dishes that indicated cooking support systems that focused on accuracy would not reflect their needs. The conclusions are, however, preliminary due to the limitations of the methodology. In the next study the self reported behaviour was triangulated with data collected from participants individually.

Chapter 4 Food and shopping diaries; tracking meal planning, shopping and cooking behaviours

4.1 Introduction

In the previous study, older adults talked about their meal planning, shopping and cooking behaviours in a series of focus groups. Although focus groups provide a way to quickly gather information from a number of people, the intrinsic biases from self-report and group social pressures mean the findings remain tentative unless triangulated with other methods of research (Adams & Cox, 2008; Rogers, Sharp, & Preece, 2011). In this study the results of the previous study are triangulated by capturing data in a 7-day food and shopping diary that was followed by an at-home interview.

The findings of the previous study suggested that there was little support for the assumptions found in the literature descripting systems to support meal planning, shopping and cooking. The design of meal planning systems, for example that created by Aberg (2009) was based on assumptions that cooks plan their meals 3-4 days in advance, look for variety between meals and use recipes or cookbooks to support their planning. The participants in the previous study seldom used recipes and made flexible plans for meals that were subject to change. The design of systems to support shopping, for example *EdibleEarth* (Bohner et al., 2009), were based on assumptions that people make most of their purchases from supermarkets and that people want to buy local and healthier foods but lack the knowledge of how to do this. The participants in the previous study actively sought out local produce from speciality stores suggesting they have no need for additional information. The design of systems to support cooking, for example *CounterActive* (Ju et al., 2001), were based on assumptions that cooks want to prepare recipes accurately and efficiently. The participants in the previous study seldom used recipes and said they like to “throw things together” when they cooked suggesting they had little interest in either accuracy or efficiency of tasks. Considering the limitations of the focus group method used in the previous study and the complexity of the tasks under investigation, it would be useful to triangulate the findings with other methods.

The tasks under investigation, meal planning, shopping and cooking, are interrelated but it is not clear how. People may, for example, plan their meals, use the plan to prepare a shopping list, perform the shopping and then execute the meal plan when they cook their meals. On the other hand they may buy a number of ingredients when they go shopping and then plan their meals from the products available in the fridge and pantry or some combination of the these patterns. As these tasks are likely to happen over a period of time, perhaps days, it would be useful to capture data over a period of days.

Considering the potential methods to be used, as technologists we seek to understand the task and the person performing the task in order to develop systems to support them. One method to do this is Contextual Inquiry (CI) (Beyer & Holtzblatt, 1997) but this is difficult to perform for activities such as meal planning, that happen over a period of days. A recent study by Comber et al (2013) used CI alongside interviews to investigate shopping and meal planning activities but did not triangulate their data with any form of longitudinal data capture.

Interviews offer an opportunity for participants to reflect back over time and can provide a rich source of information for researchers (Adams & Cox, 2008). However, the source material is the spoken word of the participant which is "of course, a highly selective, mediated portrayal of reality, which has to be interpreted by the researcher" (Medina, 2004, p. 57). Further, food and attitudes to food are morally loaded (Naccarato & LeBesco, 2012) so interviews must be performed with care and with triangulated research to balance the narrative of the interviewees.

The primary methodology selected for this study was a food diary. Diaries enable indirect observation of activities over time and are often used in HCI research (Lazar, Feng, & Hochheiser, 2010; Rogers et al., 2011). Food diaries, recording what individuals eat, are an established method of capturing and researching food intake (for example Henry & Macbeth, 2004) that can be used to understand patterns of eating in a culture or sub-culture, for example (Hughes, Bennett, & Hetherington, 2004) or to help individuals gain an oversight of their diet and effect positive changes, (for example Streit, Stevens, Stevens, & Rossner, 1991; Zepeda & Deal, 2008). In this study I extended the food diary concept to include other food related activities including meal planning and shopping, and extended the media of capture to include shopping lists and photographs of meals. The 7-day diary was followed with an at-home interview to clarify and contextualise the data gathered. This approach triangulated the self-reported data in the previous study and puts the results on sounder footing than those used in earlier HCI food related research.

4.2 Method

4.2.1 Design

The study used a self-administered diary method to capture food-related events including meal preparation and shopping. This was followed by an interview, usually located at the participant's home. The study took place during July and August 2010 and participants were able to choose the week in which they took part. A pilot study of five participants was performed in the month before the main study.

4.2.2 Participants

Thirteen participants took part in the study, mean age 68.5 years (sd=7.9). Two were male. Eight lived alone, five lived with their spouse. All were involved in the meal planning, shopping and food preparation activities of the household.

Five of the participants were also participants in the focus group study described in the previous study, a further six had expressed interest in taking part in the focus group study but did not. Two participants were recruited through a vegetarian mailing list. Fourteen participants started the study, identified as P6 through to P19 (P1 through P5 were participants in the pilot study). P7 dropped out of the study due to illness.

4.2.3 Materials

Informed consent and a copy of the 7 day food and shopping diary are included in Appendix 2.

4.2.3.1 7-day food and shopping diary

The diary was printed on A4 and bound. It comprised a single page of instructions and sections for seven days of diary entries. Each day comprised three pages to capture meal planning and cooking activities and three pages to capture shopping activity.

4.2.3.2 Disposable camera

Participants were supplied with a disposable camera with flash to take pictures on days 2,3 and 4 of the diary. Some participants used their own digital cameras and sent pictures by email.

4.2.4 Procedure

Prior to taking part, participants were sent an informed consent form with a description of the protocol and asked to sign and return the form and indicate which week they would take part in the study.

One week before the participant was due to take part, they were sent a pack including the 7-day diary, a disposable camera (if not using their own digital camera) and a stamped return envelope.

On each day during the diary study, the participant wrote about of their main meal and shopping activity. They provided a list of meals eaten, description of their main meal preparation, ingredients for the main meal, details of shopping trip and food items bought (if any) and attached a shopping list (if any). On days 2, 3 and 4 of the diary participants took photographs of their main meal preparation.

At the end of the week the participant sent the completed diary and the camera back to researcher. The photographs were developed. Then the participant was contacted to organize a follow up interview.

At the follow-up interview the food diary and photographs were used to stimulate discussion about the week and to ask questions to clarify understanding. During at-home interviews, participants were asked to give a short tour of their kitchen and show their recipe collections.

4.2.5 Data preparation

The meal diary data and shopping data were transcribed into separate spreadsheets.

The interview recordings were transcribed and then thematically analyzed using topic coding (Saldana, 2009) clustered around meal planning, shopping and cooking themes.

4.3 Results

4.3.1 Meal planning

In order to investigate the meal planning behaviour, cooks were asked to record when they planned the main meal of the day, how they made it and where ingredients and recipes were from.

Table 14: When cooks planned meals

When planned	Frequency	Percentage of meals
Planned just before preparation	18	22
Planned earlier in the day	27	34
Planned previous day or earlier	35	44
TOTAL	**80**	**100**

Table 14 shows the frequency of meals by when cooks planned them. It shows that twice as many meals (44%) were planned the previous days or earlier as planned just before the meal. Participants ate their main meal out of the home on eleven occasions during their diary weeks so the data comprised preparation and planning details of 80 meals were recorded, a mean of 6.2 meals per participant.

In order to investigate if meal planning informed shopping, the source of ingredients for the main meal was analysed.

Table 15: Source of ingredients for meals

Source	Frequency	Percent of all meals
Store cupboard	62	78
Garden	42	53
Bought for week	39	49
Bought for specific meal	31	39
Left overs	30	38

Table 15 shows the source of ingredients used for the recorded meals. Every meal had ingredients from multiple sources. It shows that nearly half of meals (49%) included ingredients purchased for a meal planned some time in the week and 39% included ingredients included at least one ingredient bought for that specific meal. These results suggest that meal planning, even if flexible about the specifics of meals, informs shopping.

In order to investigate how cooks planned their meals they were asked to expand their behaviour during the post-diary interviews. Comments were thematically organised and frequency calculated.

Table 16: Meal planning strategies and typical comments

Strategy	Typical comments	F
Immediate, just in timing planning	"when I get bored" P6	3
Same day	"I get up in the morning and think about what we're going to eat tonight" P9	4
Day before	"usually the night before because I'm planning what I am going to eat the next night so its usually the night before, sometimes it can be just a few minutes before because I am a great believe in using up what is in the fridge, I'm not very good at throwing things away" P19	1
Several days in advance, written/fixed or mental/flexible	P14 prepares bulk meals for several days "Don't want to spend all my time [cooking] because there's so much else to do" P8 uses flexible mental plan "probably over a fortnight rather than a week, you know we would sort but certainly over two weeks, some time over that but not particularly any day, just whenever" P16 fixed plan "when we are going shopping, we sit down and write what we are going to have and make a note so that we can pick up"	5
TOTAL		**13**

Table 16 shows the meal planning strategies as described in the interviews with typical comments. It shows that half the cooks plan their meals, at least at some level, in the days or day before they cook and eat them. Of these meal plans, most were held in mind only. Only one participant wrote down his meal plan, an example of this is shown below.

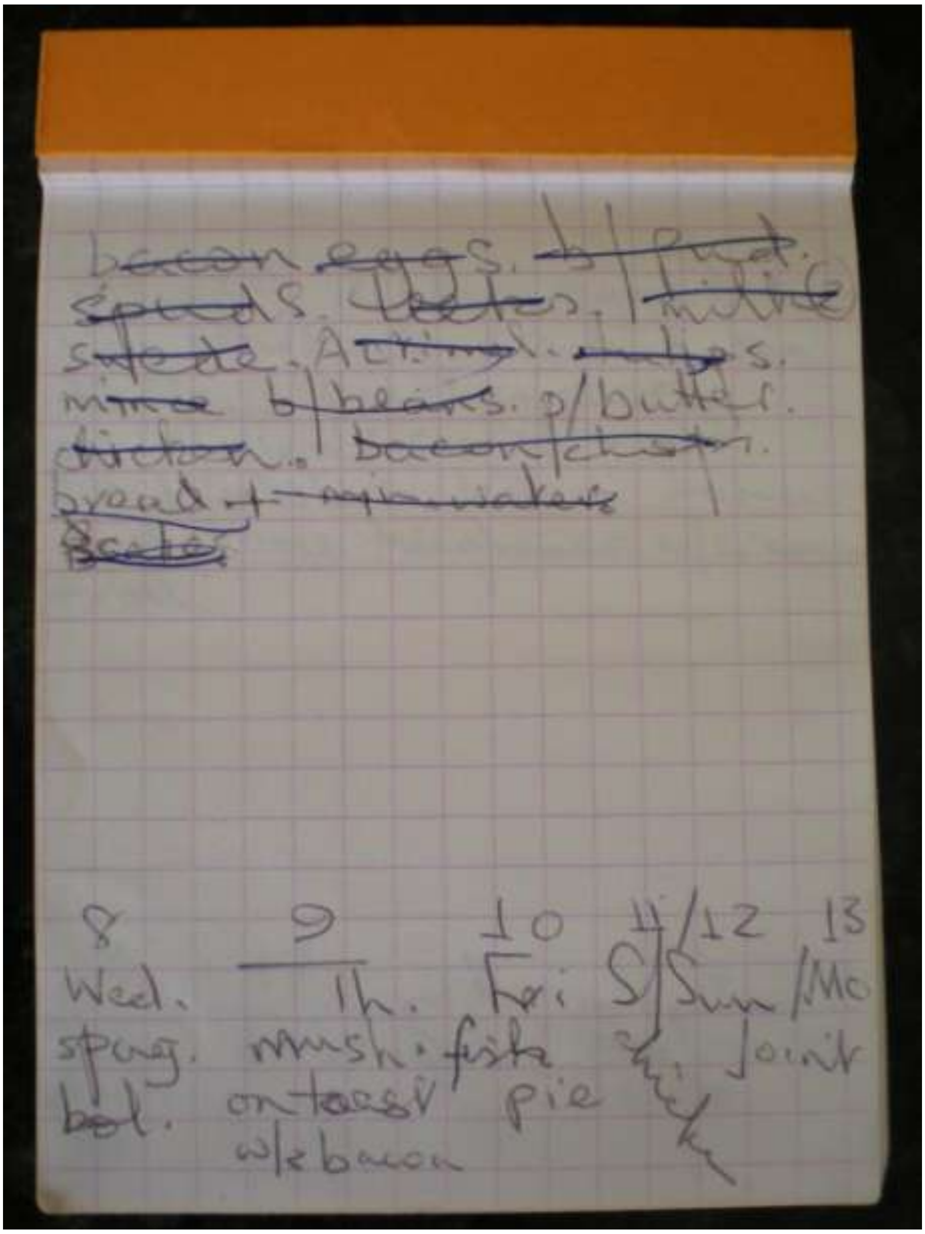

Figure 17: Shopping list and meal plan from P16

Figure 17 shows a shopping list and meal plan from the only participant who planned his meals up to a week in advance. The plan for the week ran from

Wednesday to Monday and included Spaghetti Bolognaise (Wednesday), Mushrooms on toast with bacon (Thursday), Fish pie (Friday), Chicken (Saturday), Joint (Sunday and Monday). The shopping list includes bacon, eggs, black pudding, potatoes, leeks, milk, swede, Actimel (a brand of yoghurt), tulips, mince, baked beans, peanut butter, chicken, bacon, chipolatas, bread and mineral water. Bacon appears twice on the shopping list but neither the fish nor the joint appear in the list, so it is clear the list is not double checked against the plan.

4.3.2 Shopping

In order to investigate shopping activities, participants were asked to record each time they went food shopping during the week, including their shopping list (if used), a list of food items purchased and receipt (if available). There were 57 shopping trips recorded over the 7 days by 13 participants (mean=4.4, sd=2.4). The majority (9) participants shopped 2-4 times in the week, the other four participants shopped 7-10 times in the week.

Table 17: Shopping trips with and without shopping list, by type of store

Type of store	With shopping list	Without shopping list	TOTAL	% of total trips
Supermarket	14	16	30	53
Specialist	6	17	13	23
Local store	4	5	9	16
Veg box delivery		2	2	.4
Online order / delivery	1	1	2	.4
Farm shop		1	1	.2
TOTAL	**25 (44%)**	**32 (56%)**	**57**	**100**

Table 17 shows the shopping trips performed over the diary week by type of store and split to show frequency of trips with and without shopping lists. The table shows that the majority of shopping trips were at supermarkets and 44% were undertaken with shopping lists which indicate that at least part of the shop was planned.

For each food item, participants were asked to indicate if it was one or more of the following categories:

- On their shopping list
- A regular purchase
- A spontaneous purchase

Table 18: Count of food items purchased by category

Category		TOTAL
On shopping list		**179 (40%)**
Of these, count of items also marked as		
Regular purchase	105	
Spontaneous purchase	1	
Regular purchase		**265 (60%)**
Of these, count of items also marked as		
On shopping list	105	
Spontaneous purchase	5	
Spontaneous purchase		**64 (14%)**
Of these, count of items also marked as		
On shopping list	1	
Regular purchase	5	
No category marked		**46 (10%)**
TOTAL		**443**

Table 18 shows the count of food items as categorised by the participants. The percentage of food items in each category does not add up to 100 because some items were marked with several categories.

For example the table shows that, of the 179 (40%) items that were on a shopping list, 105 (24%) were also considered to be regular purchases and 5 items were considered to be both regular and spontaneous purchases.

Figure 18: Shopping lists from P19 days 4 & 7

Figure 19: Shopping list from P13 day 5

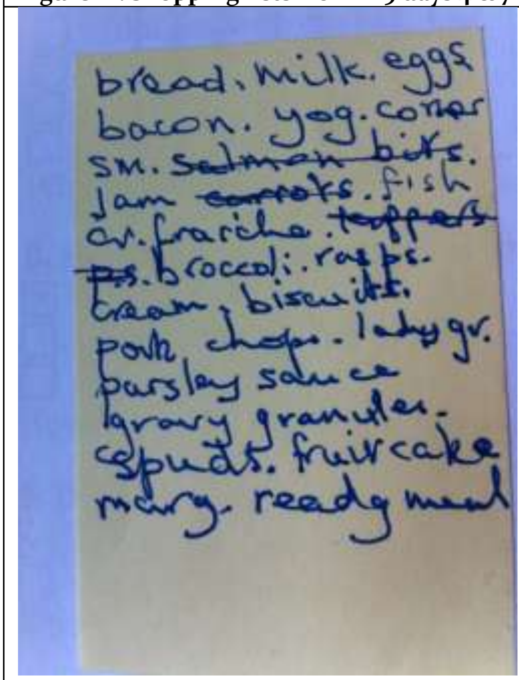

Figure 20: Shopping list from P16 day 1

Figure 21: Shopping list from P14 day 4

Several participants attached their shopping lists to the food diary. The contents were checked against the items listed in the food diary and differences triggered questions during the post-diary interviews. Figure 18-21 show shopping lists from 4 different participants. The top two show loose clustering of ingredients around meals and courses. None of the lists show any quantities for any items on the list, and there are many examples of abbreviations and of generic food items such as "stewing meat" and "fruit inc bananas".

Cooks were asked how they planned their shopping activities in the post-diary interview. The comments were thematically organised and are shown below.

Table 19: Shopping behaviours from interview and food diary

Shopping style	Typical comments	F
Weekly routine shopped mainly in supermarkets	P9 visits Tesco twice a week with no plan "We go round Tesco on a Thursday and about half way round and I'll say what do you want for lunch and we'll have a little discussion" P15 visits different supermarkets in cycle over a few weeks but no lists "when I go shopping I see some things that might come in handy for me"	5
Frequent shopping at smaller stores	P12 shops along her local high street "I will buy things like milk and cereal [from the mini supermarket] and that sort of thing and then because there is a nice baker the Pig and Pastry that you will know I will get bread from there and then go to the greengrocer next door so that is my sort of route around on a Saturday" P11 shops at small stores because "absolutely baffled by the amount of choice" at supermarkets	4
Bulk shop with top-ups	Once a month shopping, with regular top up shops at small stores or supermarkets	4
TOTAL		**13**

Table 19 shows cooks' different approaches to shopping. No cook exclusively fitted in one shopping style or another suggesting that behaviour is mixed.

4.3.3 Cooking the meals

In order to investigate how cooks prepared their meals, and if and how they used recipes, they were asked to describe the process they followed and to list the ingredients and where they came from.

Table 21 shows typical meal descriptions from three participants and section 4.3.3.1 shows a typical meal description with photographs of the preparation processes. The descriptions given were sparse, even in the case of P16 who provided the recipe for Yorkshire pudding but omitted to describe how the other parts of the meal was prepared.

Table 20: Source of recipes used to prepare main meals

Recipe source	Frequency	% of all meals
Memory	31	40
None	31	40
Other	5	7
Magazine	5	7
Friend or family	3	4
Cookbook	2	2
TOTAL	**77**	**100**

Table 20 shows that only 10 meals were prepared with the aid of a recipe. The Beef and Prune stew shown in section 4.3.3.1, prepared by P10 was one of these.

Table 21: Typical main meal descriptions from participants

Meal Title	Fish pie with vegetables. Mincemeat tart. (P11 day 1)	Carrot and lentil soup (P14, day 6)	Yorkshire puddings, meat, potato mash, veg (P16, day 3)
Meal Description	Boiled and mashed potatoes Sautéed onions and leeks Cubed plain/smoked fish and salmon Added prawns Cooked all in crème fraiche and cream Put into ovenproof dish and topped with potatoes. Sprinkled with grated cheese and breadcrumbs. Prepared and cooked veg. Made flan pastry Filled flan case Topped with pastry lattice Made custard	Peeled and sliced onion and carrots. Put in saucepan and covered with water. Added rinsed red lentils. I don't measure or weight any ingredients, just make a saucepan full. Probably a cup full. Boil for about 20 minutes until carrots soft. When cold use a stick blender to blend it. Do this in a special jug with a lid I bought with hole in lid so doesn't splash about. It's sold as a Yorkshire pudding jug. Crumble – pre cooked sliced plums in microwave until half cooked. Mixed flour, sugar, oats, seed mix together – added sunflower spread and made into breadcrumb type mix with hand pastry blender. Put on top of fruit and cooked in microwave until done. Had cold custard on top as pudding cold as made soup and pudding first thing this morning before going out.	Yorkshire pudding 2 large eggs ½ pt 8 fl oz milk pinch salt 4 hpd tablespoons bread flour splash water bun tins – drops olive oil heat fan oven to 200℃. Add this – when smoking pour in mixture. 25/30 mins. Gravy use granules and remains of mixture – bring to boil – reduce with veg water.

4.3.3.1 Typical main meal with photographs of preparation

The main meal described below was prepared with a recipe. The recipe yielded several portions so the participant portioned it and froze the excess. She said "I think it was fairly typical, I don't make a meal every week, I mean I think there were probably 3 more helpings of the stew that went in the freezer and have eaten them subsequently." Figure 22 shows the recipe clipping presented in a clear plastic holder and propped up on the bread tin in the kitchen. Figure 23 shows the recipe ingredients during preparation and Figure 24 shows the finished dish served on a plate.

The participant, P10, described the meal preparation thus:

> "Fried pieces of beef and then onions and carrots
>
> Added flour, garlic, tomato puree, bay leaf and water with stock cube
>
> Cooked in slow cooker for approx. 8 ½ hours, adding prune an hour before the end
>
> Boiled new potatoes with mint
>
> Lightly boiled cabbage with a bit of butter"

Figure 22: Recipe in holder

Figure 23: Recipe preparation

Figure 24: Beef and prune stew on plate

4.3.3.2 Recipe use

In order to investigate how recipes are used, cooks were asked to indicate when they used them and then questioned further in interviews. Their comments were thematically organised.

Table 22: Typical comments about recipe use

Theme	Count	Typical comments
Recipes are used when people come to visit	3	P8 "Usually if we have got anybody coming to dinner and I want to try to make something different or you know, I'll go to the recipe books and have a look through"
		P11 looks through her recipe binder when friends come around "the recipes in it are not particularly well organised so if somebody is coming round I can spend ages flicking through thinking I could do this, I could do that, but yeah they are all filed in boxes"
Loose recipes are collected but rarely organised	3	P11 "well they are not organised because, these are the ones that you cut out of magazines, they are not organised because what I will do is rip out a whole page and it may have pudding and it may have a starter on the same page and it may have something on the back that I don't want to lose so you can't really put them in categories"
		P19 has large amount of recipe clippings from magazines "no it's not organised. They are in a file but they are just stuffed in there. One of these days I will get around to organising it".
Recipes can be frustrating or difficult	3	P6 "I can't be bothered [to use recipes]. I look at them and think oh god how tedious. It looks hard work. It looks like studying. When I finished university I swore I'd never study again"
		P10 "It's a real fiddle to cut down the quantities"
		P14 "it's like Jamie Oliver says, just put a dash of oil and he puts half the bottle in. It's not very, you know, you need to be a bit more precise" but also admits she doesn't weigh ingredients for recipes she knows e.g. carrot & lentil soup

Most participants owned several cookbooks and most collected loose leaf recipes. These collections were stored in loose leaf binders, inside cookbooks, in recipe card tins and in baskets like the one shown in figure 12 below.

Figure 25: Recipe collection in a basket, P14

4.4 Discussion

In this study, thirteen participants completed a 7-day food and shopping diary with a post-diary interview. The data were analysed to investigate if the participants' behaviours supported assumptions made in the design of systems to support meal planning, shopping and cooking.

4.4.1 Meal planning

Considering the assumptions made in the design of systems to support meal planning, (for example Aberg, 2009) there was little support from this group of participants. With regards the first assumption that cooks plan meals 3-4 days in advance, there was little support. Only one participant planned the household meals for up to six days in advance, with each meal described at a high level, for example fish pie, chicken, "spag bol". Drawing on data from the meal diary, five participants prepared meals that were planned prior to the day they were eaten, when asked in the interview, they explained that these plans were flexible and seldom written down and are not powered by recipes. For example, P8 said she plans meals "probably over a fortnight rather than a week, you know we would sort of… [pause] but certainly over two weeks, some time over that, but not particularly any day, just whenever".

The flexible advance meal planning suggests that further decisions are made on the day or coming up to the meal as to the detail of the meal. Similar results were found by Comber et al. (2013) who interviewed people from ten households about their meal planning and shopping activities. They reported that plans were usually at a high level, identifying only the meat or central dish of the meal, and specific dishes or recipes were only chosen close to the time of preparation. Comber et al suggest that meal planning systems should enable "staggered meal planning, i.e. defining meals in progressively more detail as they move closer to preparation and consumption." (p2463).

Both this study and that of Comber et al, indicate that people go through a gradual process of planning meals, starting at a high general level that is refined to a specific meal before preparation. However, neither study captured the process over time so it is not clear how this process works in detail. It is clear, however, that the process does not match the assumptions of Aberg (2009) or of the contemporary commercial meal planning systems such as “Food on the Table”[6] that create highly detailed plans for a week from recipes. As technologists designing for users, further research is required to understand the activity before in order to inform the design of meal planning systems.

4.4.2 Shopping

Considering the assumptions made in the design of earlier systems to support cooking; that most shopping is performed in large stores with databases, that shopping is planned and that shoppers want to buy local and healthier produce, the findings from this study showed limited support. Some participants visited supermarkets once or twice a week, deciding on what to buy only when there. For example P9 said “We go round Tesco on a Thursday and about half way round and I’ll say what do you want for lunch and we’ll have a little discussion”. Others, who either did not have access to a car or chose to use a shopping trip as an excuse for some exercise visited several shops several times during the week. For example P12 shopped along her local high street with a butcher, greengrocer and bakery and P10 visited several different stores in the city centre with her backpack.

The results indicate a complex and flexible pattern of shopping that does not support the assumptions of earlier shopping support systems. There was no evidence from the interviews or shopping diaries that the cooks were interested in being nudged towards more local or healthy foods.

Considering how they planned shopping, fewer than half the shopping trips

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[6] http://www.foodonthetable.com/

were supported with shopping lists and fewer than half the products bought were on lists. Much of the shopping, therefore, relies on memory, i.e. habitual purchases, or is triggered by displays of food in store. The findings also suggest that purchases are only loosely linked to planned meals. In a recent study, Comber et al (2013) who observed participants during shopping trips they called “shop-a-longs”. They questioned them about their decisions and found that participants “tended to be unreflective about such routines, particularly how purchasing was related to consumption and potential food waste” (p2465). In other words they found that people shop and cook but do not reflect on their plans or outcomes.

The participants in this study had mixed shopping routines that incorporated both supermarkets and smaller stores. It was clear the participants had knowledge of where to buy local and quality foods and had no need for additional information or nudging towards healthier or more local foods. The findings show little support for the assumptions in earlier systems designed to support shopping.

4.4.3 Cooking

Considering the assumptions of earlier systems to support cooking, for example to help them prepare recipes accurately and with confidence, there was little evidence that these participants were in need of or desired this level of support. Firstly, few of the meals were prepared using recipes and of those that were, cooks indicated that they were not focused on preparing them accurately. Only one example of accurate measures was seen in the recipe given for Yorkshire pudding by P16.

When cooks did use recipes they were drawn from memory and adapted to suit the cooks’ style of cooking and available ingredients. For example P14 made a carrot and lentil soup that she “did make from a recipe when I first made it”. In the interview she explained how she made it according to available carrots and depending on what style of soup she fancied that day;

“when I make soup I don’t weigh the carrots or lentils I just put in what I think, if I want, if I’ve got lots of carrots and I want to make a really thick soup, so I don’t really weigh much I just throw in”.

These findings suggest that assumptions of systems such as *Cooks’ Collage* (Tran et al., 2005) that aimed to help cooks ensure accurate measures when following a recipe were not supported for this group of participants.

Considering how recipes were used by this group of participants, only five of the 80 meals reported were made with recipes. During the post-diary interview cooks said they did use recipes for special meals and when guests came to visit. Using recipes for making a meal for one was “a real fiddle” (P10) because they were seldom written for a single person at a single meal. Both P10 and P14 reported making meals that were portioned up and stored (usually frozen) for eating later. This approach to cooking helped the participants in two ways. Firstly they described it as difficult and less energy efficient to make a dish in a single portion and secondly it reduced the amount of cooking work to be performed on future days.

During the post-diary interviews, cooks brought out and discussed their recipe collections. Nearly all cooks in the study had a recipe collection, and each contained a large number of clipped recipes. These collections were rarely organised, just stuffed in files. One of the problems of organisation was that recipes for different courses were on the same paper; “it may have pudding and it may have a starter on the same page and it may have something on the back that I don’t want to lose so you can’t really put them into categories” (P11). The advantage of recipes in clippings was that they could be taken into the kitchen as individual recipes and propped up on bread bins or toasters or whereever there was room.

This last behaviour highlighted the assumptions in earlier systems that there was ample free space available in kitchens. For example *PersonalChef* (Mennicken et al., 2010) that took up wall and counter space, and *Living*

Cookbook (Terrenghi et al., 2007) that took up large amount of wall space. This assumption is culturally biased towards North American kitchens and does not generalise to city homes in the north of England (Bell and Kaye, 2002). In contrast to the designs of earlier recipe support systems such as *Personal Chef* (Mennicken et al., 2010) these findings indicate that technologies to support recipe use must be small and flexible in where they can be placed in the kitchen.

4.4.4 Limitations of the study

As for the previous study, participants were self-selected and expressed an interest in food and cooking that could not be generalised to the wider population. The diary method offered indirect observation of food related activities over a week, however the it was reliant upon participants completing the pages at the appropriate time. There were several gaps in the data, some were less detailed than expected and in the interviews, a number of participants indicated that they completed the diary at the end of the day or beginning of the next day, thus relying upon recall.

4.4.5 Conclusion

Where, earlier HCI food related systems have assumed people make detailed meal plans, shopping lists and follow recipe instructions for cooking, findings of this study and the previous, highlight that much food related behaviour is both routine and flexible. Most participants make rough meal plans in their heads, but only fix meals on the day, sometimes just before a meal is prepared. They make shopping lists for some visits but rely heavily on memory to purchase foods for the store cupboard. Most meals are made without reference to recipes and when recipes are used they are adapted to suit the needs of the cook.

Findings of this study provide a richer picture of participants' food related behaviour than the previous study. Results from this and from Comber et al (2013) indicate there is a pattern to meal planning but further specific research is required to understand how planning changes over time and what technical support might benefit cooks. Although the focus on accuracy of earlier recipe support systems may not be of interest to these participants, they still collected recipes and would benefit from systems that could help them organise recipes and scale them down to portions for one or two.

Chapter 5 Investigating the Design of Recipes for Interactive Recipe Systems

The first two studies of this thesis investigated the cooking and other food related activities of older adults to see if they were in need of technological support and to investigate if the assumptions of earlier food related interactive systems generalised to older adults. The motivation for these studies was drawn from a gap in the literature – most of the earlier research has focused on the needs of younger adults – and also from the experience and focus of the research at the University of York.

The findings of the first two studies showed that each area of human-food interaction that was investigated; meal planning, shopping and cooking, presents a rich area of activity and potential design sites where technologists might offer assistance. It was clear that each area is complex and needs more user research to understand how people perform their tasks and the problems they encounter. For example, the benefit of meal planning systems could extend to everyone, no matter their age. Meal planners offer the opportunity to plan a balanced and healthy diet (Iglesius et al., 2010), to organise food chores around a busy family lifestyle (Snyder et al., 2007) and to ensure every one eats well within a budget, for example the commercial system FoodontheTable[7]. Each of these systems, however, assumes that cooks will plan meals for a week or more in advance, using recipes and they will prepare their meals from these recipes. The findings of the first two studies showed, in common with Comber et al. (2012) that the process of meal planning is performed over time, iterative and flexible and not amenable to the highly detailed planning offered by the academic and commercial meal planning systems.

Considering the scope of human-food activities, and the findings of these earlier studies that suggested each area was a potential site for research, it was important to narrow the focus of the research project to a single area. In

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[7] http://www.foodonthetable.com/

talking with participants in the earlier studies about their food habits, it was inevitable that every conversation turned to recipes. While they did not use recipes on a day-to-day basis, nearly every participant had a collection of recipes and all participants had stories to tell about them. It is clear that recipes are inextricably linked to the way we think about and talk about food and other food-related activities. They are important on a personal level because they provide us links with the family past (Supski, 2005) and help construct our identities in the present (Wright St. Clair, 2005) and on a social level reflecting our interest in exploring new cuisines (Brownlie, Hewer and Horne, 2005) and our gendered approach to cooking (Neuhaus, 2003).

The recipe is also important in the design of interactive systems for food related activities. Recipes were used in systems to support meal planning (e.g. Aberg, 2009) and shopping (e.g. Bohner et al., 2009) as well as cooking. Considering the systems designed to support cooking in particular, the literature review found that all the systems used recipes but none discussed how cooks used recipes. An underlying design assumption of these systems was that cooks wanted help to follow recipes accurately. This assumption was not supported by the findings of the earlier studies.

In fact the literature review found none of the interactive recipe systems cited research that investigated how cooks followed recipes in support of their design decisions. The failure to draw on user research was pointed out in 2002 by Bell and Kaye (2002) and to date has not been addressed in the field. Lacking an understanding of how cooks cook limits the ability of researchers to investigate how to help them with problems, and to develop novel innovative systems that are effective and offer great user experience.

The contribution of earlier interactive systems has been on novel technical ideas for the kitchen. For example *Kitchen of the Future* (Siio et al., 2007) included multiple displays along the kitchen wall with a foot switch to control where the recipe and videos are shown, and *PersonalChef* (Mennicken et al., 2010) implemented a display behind the stove for life size personal chef to show you how to cook and another inlaid into the work surface. In *LivingCookbook* (Terrenghi et al., 2007) a projector was used to replay videos on the kitchen wall and in the Nutrition Aware kitchen (Chi et al., 2008), scales were built in under the stove and work surfaces to measure small changes in food weight.

All these designs present large-scale technical interventions in the kitchen. They do not offer solutions that can be implemented in smaller kitchens of European homes (Bell and Kaye, 2002) or reflect technology that is currently accessible to all. In recent years however, mobile devices such as tablets and smart phones have become ubiquitous and there now millions of recipes available online to take into the kitchen with us. Thus, it would be useful to investigate interactive design of recipes for the small screens of mobile devices.

In reviewing the literature of interactive recipe systems I noted that the presentation of recipe instructions was not the same as the traditional recipe format. They presented instructions in short steps, often with ingredient quantities included in the text of the recipe step. This is different from traditional form of recipes. These are issues of instruction design of which there is a large body of research, yet none of the earlier interactive recipes systems discussed the design of their instructions nor drew on the instruction design research. This represents a gap in the research that would be useful to investigate in order to inform the design of effective interactive recipe systems.

Thus, the final two studies of this thesis investigate how cooks interact with recipe instructions in different formats. The objectives of these studies was first to understand how cooks interact with recipe instructions, and then to test the effect of short instructions, integrated instructions, adding pictures and presenting an overview of the recipe procedure. Considering the objective of these studies was to investigate how cooks interact between recipe instructions and tasks rather than a specific demographic of users and also considering the difficulty in recruiting older adults to studies, the following studies recruited students at the university as participants. The outcomes can be used to inform the design of useful, usable and effective interactive recipe systems designed to present libraries of textual recipes on mobile devices.

Chapter 6 RECIPE1: Investigating the Effect of Segmenting and Integrating Recipe Instructions

6.1 Introduction

This experiment was designed to answer three questions: Firstly, how do cooks interact with recipe instructions? Secondly, does the length of individual recipe instructions affect the cook and if so how? And thirdly, does the location of key information in a recipe, in this case, ingredient quantity and preparation instructions, affect the cook and if so how?

6.1.1 Segmented instructions

In the traditional format of recipes the method instructions are often presented in long paragraphs containing many tasks that may be difficult for cooks to follow. Advice for recipe writers states that long paragraphs can be difficult for the cook: “solid blocks of type are not easy to follow” (Whitman, 1993, p31) and “long blocks of type … are daunting to the reader and make it difficult to find one’s place” (Gibbs Ostmann and Baker, 2001, p22), but, both Whitman and Gibbs Ostmann and Baker justify their use if the author prefers a narrative style or if necessary to adhere to page layout restrictions. Hertzmann (2010) points out that the modern format of printed recipes is “modified and typeset to fit a pre-defined space rather than best to communicate with the reader” (p171) and this “caus[es] some recipes to be easier to follow than others” (p171). To consider how cooks interact with instructions in long paragraphs, take the second paragraph in Figure 26.

▸ Heat the oil in a large saucepan, add the onions, carrots and celery and cook over a medium heat for about 5 minutes, until tender but not coloured. Add the garlic and chilli (if using), and cook for a further minute.
▸ Cut a small cross on the underside of each tomato, place in a bowl and cover with boiling water for 30 seconds. Run the tomatoes under cold water to loosen the skin, then peel them and cut them into quarters. Add the tomatoes and tomato purée to the saucepan. Cover and cook over a low heat for about 45 minutes to 1 hour, or until the vegetables are really tender.
▸ Pour the mixture into a blender and whiz until smooth. Tip back into the saucepan and continue to cook over a low heat for a further 20 minutes, until thickened.
▸ Taste the sauce and add a little sugar and seasoning.

Figure 26: Method instructions for Home-made fresh tomato sauce for pasta by Ainsley Harriott

The cook could either read the whole paragraph and commit it to memory or read each sentence, perform the task and then search the paragraph to find their place again. If they attempt the former they have to memorise the tasks and perform them from memory. This can increase cognitive load and lead to errors (Ganier, 2004). If they read and perform one step at a time they have to search the paragraph for the next step several times.

One way to reduce the cognitive load on the user is to present instructions in short, numbered steps to make it easy for users to find their place again. Duggan and Payne (2001) found that short instructions can be performed in shorter time and with fewer errors because users can "execute the procedure while reading with a minimal load on memory" (p298).

It is not clear, however, if these performance benefits associated with short instructions are applicable to cooking. Previous research on the design of instructions has focused on simple tasks such as knot tying (Eiriksdottir & Catrambone, 2008), deleting an item in a spreadsheet (Ummelen, 1997) or setting up a virtual telephone system (Karreman et al., 2005). Each of these tasks had simple sequential instructions but, as described in section 2.2.1, recipes have more a more complex design of instructions often containing backwards references and parallel tasks. The effect of instruction length in recipes has not previously been investigated. However, interactive recipe systems often make use of short instruction steps.

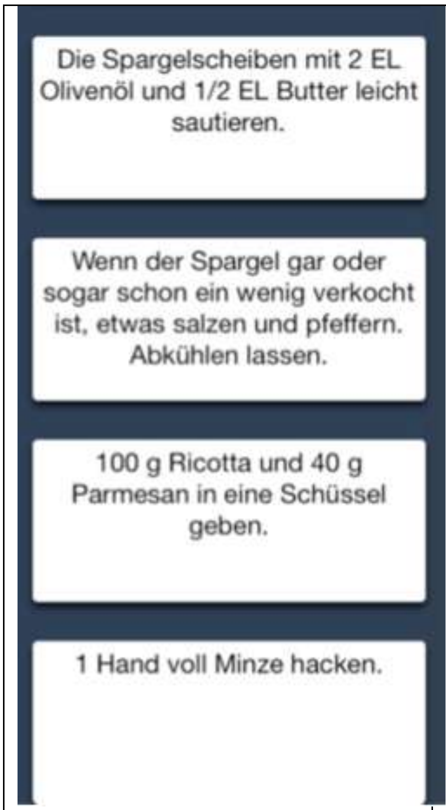
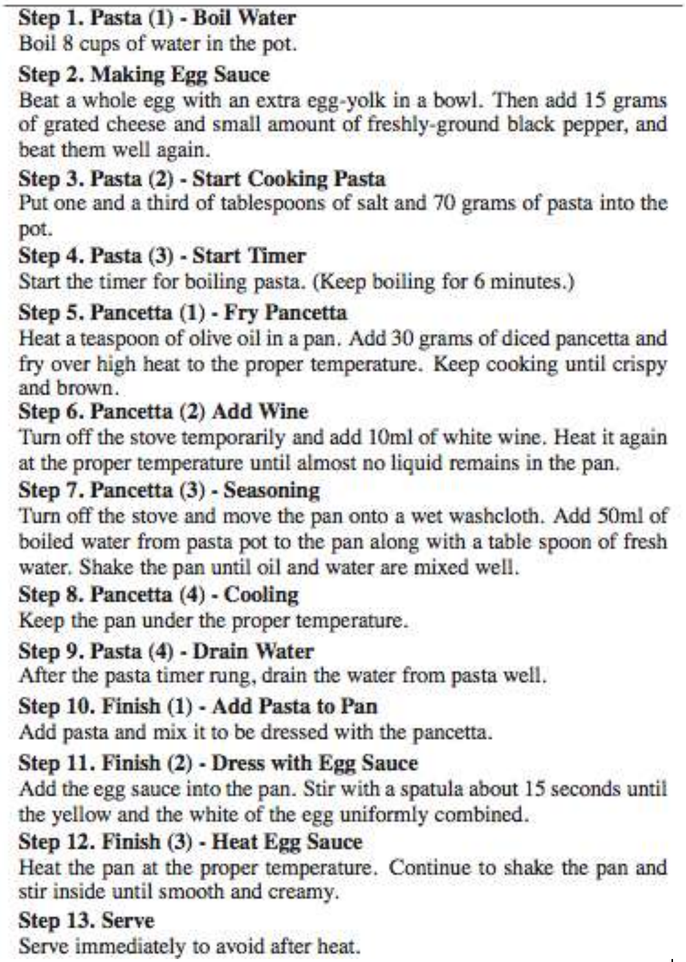


Figure 27: Short steps in PersonalChef method instruction



Step 1. Pasta (1) - Boil Water
Boil 8 cups of water in the pot.

Step 2. Making Egg Sauce
Beat a whole egg with an extra egg-yolk in a bowl. Then add 15 grams of grated cheese and small amount of freshly-ground black pepper, and beat them well again.

Step 3. Pasta (2) - Start Cooking Pasta
Put one and a third of tablespoons of salt and 70 grams of pasta into the pot.

Step 4. Pasta (3) - Start Timer
Start the timer for boiling pasta. (Keep boiling for 6 minutes.)

Step 5. Pancetta (1) - Fry Pancetta
Heat a teaspoon of olive oil in a pan. Add 30 grams of diced pancetta and fry over high heat to the proper temperature. Keep cooking until crispy and brown.

Step 6. Pancetta (2) Add Wine
Turn off the stove temporarily and add 10ml of white wine. Heat it again at the proper temperature until almost no liquid remains in the pan.

Step 7. Pancetta (3) - Seasoning
Turn off the stove and move the pan onto a wet washcloth. Add 50ml of boiled water from pasta pot to the pan along with a table spoon of fresh water. Shake the pan until oil and water are mixed well.

Step 8. Pancetta (4) - Cooling
Keep the pan under the proper temperature.

Step 9. Pasta (4) - Drain Water
After the pasta timer rung, drain the water from pasta well.

Step 10. Finish (1) - Add Pasta to Pan
Add pasta and mix it to be dressed with the pancetta.

Step 11. Finish (2) - Dress with Egg Sauce
Add the egg sauce into the pan. Stir with a spatula about 15 seconds until the yellow and the white of the egg uniformly combined.

Step 12. Finish (3) - Heat Egg Sauce
Heat the pan at the proper temperature. Continue to shake the pan and stir inside until smooth and creamy.

Step 13. Serve
Serve immediately to avoid after heat.

Figure 28: Short steps in Panavi method instructions

Earlier interactive recipe systems, such as *PersonalChef* (Mennicken et al., 2010) and *Panavi* (Uriu et al., 2012) presented method instructions in short steps, as shown in Figure 27 and Figure 28. The authors reported that the cooks who used these systems used the textual instructions as their primary source of information for how to prepare the recipe. The experienced cooks who used *Panavi* (Uriu et al., 2012) followed the recipe texts and only sometimes consulted the supporting video. Similarly, some cooks who used *PersonalChef* (Mennicken et al., 2010) followed the textual method instructions without reference to the videos, while others consulted video support only when they were unsure of the textual instruction.

The findings of Duggan and Payne (2001) and Ganier (2004) suggest that the design and format of the method instructions is likely to be a factor in the overall success of an interactive recipe system. However, Mennicken et al. (2010), Uriu et al. (2012) and other designers of early interactive recipe systems did not describe how they designed the format of their method instructions and they did not evaluate them against the traditional paragraph format. It is not clear from this early research what effect, if any, short method instruction steps had on the usability of the systems and the user experience of the cooks.

6.1.2 Integrated instructions

Another feature of the method instructions seen in the early recipe support systems is that they contained all the information necessary to perform the task including the quantities needed of each ingredient and the preparation instructions. When using the traditional recipe format cooks have to switch attention between the method instruction and the ingredient list to assemble the information. The earlier researchers did not evaluate whether or not organising the recipe content this way contributed to the success of the systems.

The traditional design of recipes, with a "separate list of ingredients and quantities, sometimes with preparation instructions, has become the standard in recipe writing." (Hertzman, 2009, p171). This separate ingredient list has value for the cook by providing clues to the cook of flavours and textures in the recipe, helping them decide "whether the recipe is something he wants to try" (Whitman, 1993, p14). This format also provides a "quick, easy-to-read pantry checklist and/or shopping list" (Gibbs Ostmann and Baker, 2001, p8) and when preparation instructions are included, enables experienced cooks to assemble and prepare all the ingredients - known as *mise-en-place* - before starting the method instructions (Tominson, 1986; Whitman, 1993).

Little research, however, has investigated how cooks use recipe instructions so it is not clear if cooks, experienced or not, routinely perform mise-en-place when preparing recipes. Gibbs Ostmann and Baker (2001) acknowledge that cooks do not mise-en-place when they say that cooks "discover halfway through the preparation that they don't have a necessary ingredient" (p14). Albala and Nafziger (2010) go further and suggest that mise-en-place is unnecessary for everyday cooking – and it produces a great deal of washing up.

Serves 6–8
Preparation 10 mins
Cooking 1¾ hrs

3 tablespoons extra-virgin olive oil
2 onions, chopped
1 medium carrot, chopped
1 stick celery, diced
3 fat cloves garlic, crushed
pinch of crushed dried chillies (optional)
1 kg (2¼ lb) ripe tomatoes
2 tablespoons tomato purée
1–2 teaspoons caster sugar
salt and freshly ground black pepper

Figure 29: Ingredients list for Home-made fresh tomato sauce for pasta by Ainsley Harriott

If a cook does not mise-en-place but starts preparing the recipe with the first task in the method instructions they must switch attention to look up information in the ingredients list and integrate it into the method instruction step held in memory. To explicate the challenge facing the cook, consider the recipe shown in Figure 29 and Figure 26. In the first step of the method instructions the cook is instructed to add the onions, carrots and celery. Referring to the ingredient list, they will discover they need to chop the onion, chop the carrot and dice the celery before they can add them to the saucepan. Each of these tasks takes some time, during which the oil is heating, perhaps unduly.

When using a traditionally formatted recipe, the cook has to mentally elaborate and integrate multiple instructions from the ingredient list and from the method instruction step to form an action plan (Paas, Renkl, & Sweller, 2003). This process of integrating information from split sources has been found to increase the cognitive load of instruction users (Chandler & Sweller, 1991).

The separate ingredient list and method instructions is not seen in recipes within the early interactive recipe systems, such as *PersonalChef* (Mennicken et al., 2010), *Panavi* (Uriu et al., 2012) and *HappyCooking* (Hamada et al. 2005).

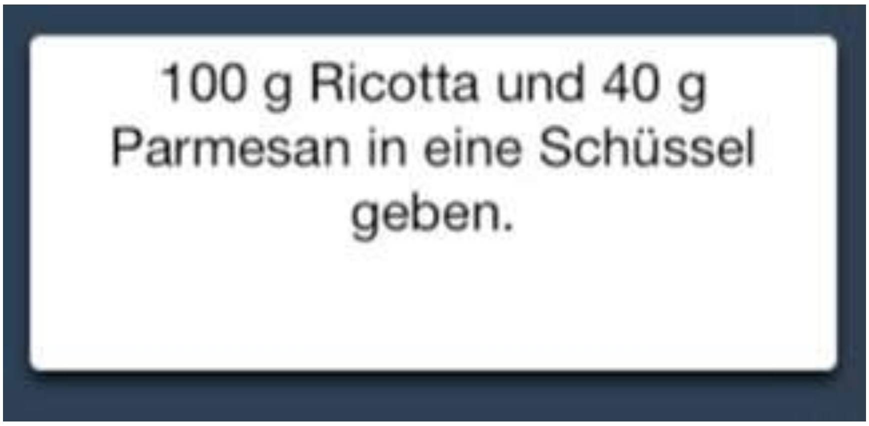


Figure 30: Ingredient quantities included in method instructions of PersonalChef

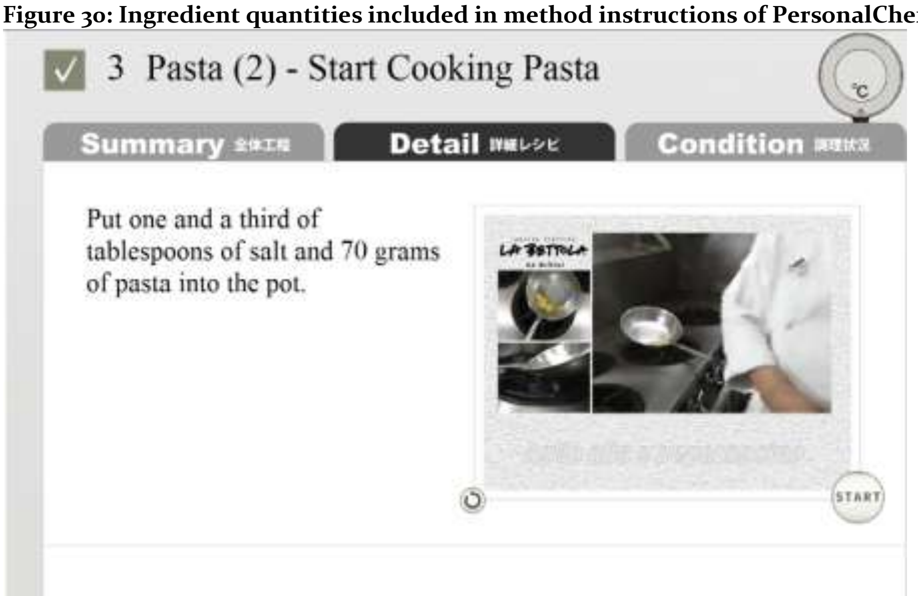


Figure 31: Ingredient quantities included in method instructions of Panavi

Figure 30 and Figure 31 show that ingredient quantities were included in the method instructions of *PersonalChef* (Mennicken et al., 2010) and *Panavi* (Uriu et al., 2012). This enabled cooks to read and perform the method instruction without referring away to the ingredient list and the need to integrate the information and generate an action plan. Thus the design reduced the cook's cognitive load. The designers of these systems did not evaluate the effect of integrating ingredient information into the method instructions so it is not clear what effect, if any, it had on the success of cooks using their systems.

6.1.3 Research questions

Considering the early interactive recipe systems such as *PersonalChef* (Mennicken et al., 2010), *Panavi* (Uriu et al., 2012) and *HappyCooking* (Hamada et al., 2005), the cooks who used these systems enjoyed their experiences and were reported to successfully prepare their recipes. Each of these systems presented method instructions in short steps with information integrated from the ingredient list. Findings from instruction design research suggest these factors may have contributed to the overall success of the systems but the earlier researchers did not evaluate it.

Researchers in the field of Natural Language Processing (NLP) and semantic analysis (e.g. Makino et al., 2009) have shown that the structure of recipe instructions can be identified and the text of the instructions transformed into different formats and representations. This suggests there is potential to take the text of traditionally formatted recipes and algorithmically integrate ingredient information into the text of method instructions and segment them into short steps for the benefit of the cook.

It is therefore useful to investigate the effect, if any, of segmenting and integrating information into recipe method instructions to inform the design of future recipe support systems. Therefore this study will investigate the effect of (1) segmenting recipe instructions and (2) integrating information into the recipe instructions. To do this, however, requires understanding of how cooks interact with traditional recipes.

Early interactive recipe systems made assumptions about how cooks used recipes and about the problems that cooks experience. For example, Mennicken et al. (2010) aimed to raise the confidence of hobby-chefs preparing novel recipes and Hamada et al. (2005) aimed to optimise the task flow of cooks preparing several recipes. Little detail was provided to describe how cooks interacted with their systems and what problems and errors, if any, they experienced. As a result there is little basis on which future designers can build.

There is a general lack of contextual inquiry research investigating how cooks use traditional recipes. So it is not clear what behavioural pattern is found when cooks work with traditional recipes and whether this pattern is modified when using different recipe designs as found in the earlier interactive recipe systems. Further, despite recipes being one of the most common forms of instruction sets, there is a lack of instruction design research that investigates recipe instructions.

This study, therefore, sets three research questions:

- How do cooks interact with recipe instructions?
- How do segmented method instructions affect cooks?
- How do integrated method instructions affect cooks?

In order to understand how cooks interact with recipe instructions in different presentations, this study observes cooks using recipes in a control presentation (the traditional recipe format), a segmented instruction presentation and an integrated instructions presentation. The study investigates the reading patterns, problems, errors and behaviours with implications for design and compares them across the different Recipe Presentations. In order to investigate the effect, if any, of short instructions or integrated instructions on efficiency and on cooks' experience of the recipes, quantitative measures of time to complete and time to read the instructions were taken and cooks were asked to rate the recipes.

6.2 Method

6.2.1 Design

The study had a repeated measures design with two independent variables: Recipe and Recipe Presentation. Recipe had three levels: Spicy tomato and bean dip (Dip), Lemongrass and lime chicken burgers (Burgers) and Key Lime pie (Pie). Recipe Presentation had three levels: Control, Segmented instructions, Integrated instructions. The recipe formats are outlined below in section 6.2.4.

Data was captured for both quantitative and qualitative analysis providing a rich study of the patterns of cooks' behaviours supported by quantitative measures of time taken to read and complete the recipe and cooks' ratings of their experience with the recipes.

The order of Recipe Presentation was counterbalanced with two cyclic-design Latin squares. Table 23 shows how participants were allocated to one of six differently ordered groups of Recipe Presentation. For the purposes of analysis, participants 1-12 were located in the first Latin square and participants 13-24 were located in the second Latin square.

Table 23: Order of conditions presented to participants

Recipe/ Participant ID Range	Pie	Burgers	Dip
1-4	Integrated	Segmented	Control
5-8	Control	Integrated	Segmented
9-12	Segmented	Control	Integrated
13-16	Control	Segmented	Integrated
17-20	Integrated	Control	Segmented
21-24	Segmented	Integrated	Control

6.2.2 Participants

There were 24 participants, 8 in each condition. There were 12 women (50%). The participants ranged in age from 18 to 24 years (M=20.6, SD=1.8). All participants were students at University of York, 20 (83%) were undergraduates, 4 (17%) were postgraduates. Twelve participants were reading for science and engineering degrees, 12 were reading for arts and humanities degrees. Participants were a convenience sample recruited through advertisements in student newsletters.

6.2.2.1 Participant cooking skills and experience

Considering the cooking experience of the participants, this varied but none were absolute novices. Seventeen (10 women, 7 men, 71%) of the participants learned to cook with their parents, 13 (7 women, 6 men, 54%) of the participants described themselves as self-taught and 5 (3 women, 2 men, 21%) learned to cook at school. Five participants learned to cook with parents and at school. Seven learned to cook with parents and were self-taught. Eleven (5 women, 6 men, 46%) of the participants cooked everyday, 10 (5 women, 5 men, 42%) cooked most days of the week and the 3 other participants cooked at least once a week.

Considering the recipe experience of the participants, all had used recipes but few used them in day-to-day cooking. One female participant used recipes most days, nine (3 women, 6 men, 38%) participants used recipes 1-3 times a week, eight (6 women, 2 men, 33%) used recipes 2 or 3 times a month. Seven (3 women, 4 men) participants used recipes once a month or only for special occasions. Of the recipes they had used recently, all twenty-four cooks (12 women, 12 men) said they used recipes from websites. Seventeen (7 women, 10 men, 71%) of participants used recipes from cookbooks, and 14 (8 women, 6 men) used recipes from friends and family. Six (6 men) had used recipes from magazines and three (3 men) had used recipe cards from supermarkets.

The participants were randomly assigned to the experimental conditions. All food ingredients were provided for the participants to prepare the recipes and they took the finished dishes away after their participation. In taking part in the study, participants were performing the role of cook, so in discussing observations of their activity and comments I will refer to them as cooks.

6.2.3 Equipment and materials

6.2.3.1 Kitchen

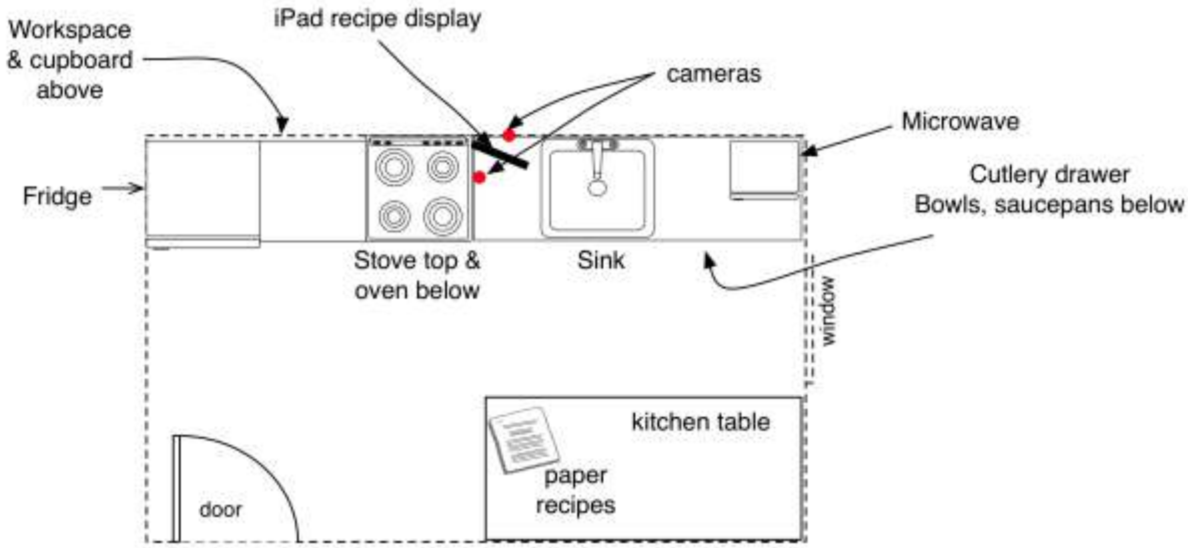


Figure 32: Kitchen layout

The study took place in the HomeLab in the Department of Computer Science at the University of York. Figure 32 shows the layout of the kitchen. The working area for the cook was laid out along the kitchen wall in a style common to many British kitchens. From left to right was the fridge, a workspace about 1m square, the stove and oven, the recipe display, the sink and then a further small work space with the microwave. Food ingredients were stored in the fridge and in the cupboard to the right of the fridge. Cutlery, utensils, bowls and saucepans were stored in the drawers under the microwave.

6.2.3.2 Recipe Presentation: iPad

During the cooking sessions the recipes were presented to the cook on an iPad. This was in a fixed location as shown in Figure 32.

6.2.3.3 Recording equipment

One camera was used to capture the cooks' activities and another to capture the recipe step currently visible on the iPad. Figure 32 shows the location of the cameras above and in front of the iPad. Figure 33 shows video capture of the cook interacting with the iPad recipe. The feed from the cameras was recorded using Morae on a PC in an adjacent room. A microphone was used to record the participants' speech.

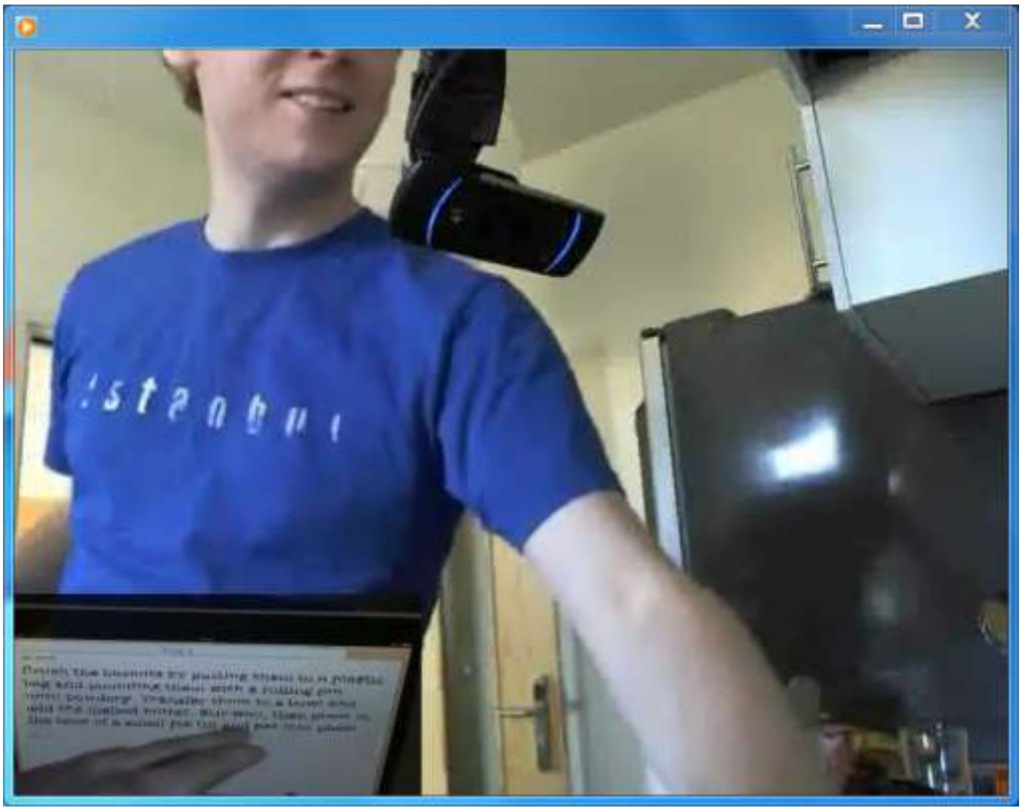


Figure 33: Video capture of cooks' interaction with iPad

6.2.4 Recipes

6.2.4.1 Recipe levels

Three recipes were used in the study: Spicy tomato and bean dip (Dip) from *The Thrifty Cookbook: Delicious Recipes to Feed Your Family on a Budget* (2010, p. 47), Lemongrass and lime chicken burgers (Burgers) from *Market Kitchen*

Cookbook (Allen & Lamb, 2010, p. 85) and Key Lime pie (Pie) from *Momma Cherri's Soul in a Bowl Cookbook* (Jones, 2007, p. 144).

The recipes were selected from cookbooks found in York Explore Library[8]. They were selected because they included a range of cooking techniques and food styles. In a trial by two independent cooks (myself and a colleague) each recipe was successfully prepared within 30 minutes

6.2.4.2 Recipe Presentation levels

The recipes were presented in three levels: Control, Segmented instructions and Integrated instructions. Table 24 shows the Pie recipe in all three Recipe Presentations. All Recipe Presentations for the Burgers and Dip recipe are shown in Appendix 3.

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[8] http://www.york.gov.uk/directory_record/91/york_explore_library

Table 24: Recipe Presentation levels for Recipe Pie

Recipe Presentation	Control	Segmented instructions	Integrated instructions
Ingredient list	125 g gingernut biscuits 65 g butter, melted 200 ml sweetened condensed milk 1 egg 60 ml lime juice 1 tablespoon lemon juice from 1 lime lime zest icecream, to serve lime slices, to serve	125 g gingernut biscuits 65 g butter, melted 200 ml sweetened condensed milk 1 egg 60 ml lime juice 1 tablespoon lemon juice lime zest from 1 lime icecream, to serve lime slices, to serve	125 g gingernut biscuits 65 g butter 200 ml sweetened condensed milk 1 egg 60 ml lime juice 1 tablespoon lemon juice 1 lime To serve icecream lime slices
Method instructions	1. Crush the biscuits by putting them in a plastic bag and pounding them with a rolling pin until powdery. Transfer them to a bowl and add the melted butter. Stir well, then place in the base of a small pie tin and pat into place. 2. Put the condensed milk and eggs in a bowl and stir with a fork, gradually adding the lime and lemon juice. The mixture will begin to thicken. Add half the lime zest and pour the mixture on top of the ginger crust. Sprinkle the remaining zest on top. Place in an oven preheated to 180°C/Gas Mark 4 and cook for 10 minutes only. Don't be	1. Crush the biscuits by putting them in a plastic bag and pounding them with a rolling pin until powdery. 2. Transfer them to a bowl. 3. Add the melted butter. 4. Stir well. 5. Place in the base of a small pie tin and pat into place. 6. Put the condensed milk and eggs in a bowl and stir with a fork. 7. Gradually add the lime and lemon juice. The mixture will begin to thicken. 8. Add half the lime zest. 9. Pour the mixture on top of the ginger crust. 10. Sprinkle the remaining zest	1. Preheat the oven to 180°C/Gas Mark 4. 2. Zest the lime and set aside. 3. Crush 125g biscuits by putting them in a plastic bag and pounding them with a rolling pin until powdery. 4. Transfer them to a bowl. 5. Melt 65g butter. 6. Add the butter to the biscuit crumbs, and stir well. 7. Grease a small pie tin. 8. Put the biscuit mixture into the small pie tin and pat into shape so it covers the base. 9. Put 200ml condensed milk and 1 egg in a bowl and stir with a fork. 10. Gradually add 60ml lime and 1

	fooled by the look of the pie into thinking you need to cook it for longer. It is meant to be custard-like. It is not a baked cheesecake, although it does look and taste a bit like one. Once cooled, place in the fridge where it will continue to set. Serve with icecream or whipped cream.	on top. 11. Place in an oven preheated to 180°C/Gas Mark 4. 12. Cook for 10 minutes only. Don't be fooled by the look of the pie into thinking you need to cook it for longer. It is meant to be custard-like. It is not a baked cheesecake, although it does look and taste a bit like one. 13. Once cooled, place in the fridge where it will continue to set. 14. Serve with icecream or whipped cream.	tablespoon lemon juice, and continue stirring. The mixture will begin to thicken. 11. Add half the lime zest to the condensed milk mixture and mix well. 12. Pour the mixture on top of the ginger crust. 13. Sprinkle the remaining zest on top. 14. Put the pie in the oven and cook for 10 minutes only. Don't be fooled by the look of the pie into thinking you need to cook it for longer. It is meant to be custard-like. It is not a baked cheesecake, although it does look and taste a bit like one. 15. Leave pie to cool where it will not be disturbed. 16. Once cool, place in the fridge where it will continue to set. 17. Decorate with slices of lime and serve with icecream.

6.2.5 Recipe delivery

A printed copy of each Recipe in each Recipe Presentation was prepared. Cooks were shown the set corresponding to the conditions they were taking part in during the briefing in order to familiarise themselves and to identify any allergenic ingredients. During the cooking session the recipes were presented on the iPad using the recipe software described below during the cooking sessions and the printed copies were left on the kitchen table for reference if required.

6.2.5.1 Recipe software

The recipes were imported from text files to MacGourmet v3.1 installed on a Mac Book Pro 2.53GHz Intel Core 2 Duo with 4 Gb memory running OS X version 10.6. The Recipes were subsequently imported to the MacGourmet iPad app v3 on the iPad for display to the cooks.

The MacGourmet iPad app provided an off-the-shelf solution to tracking the cooks' reading pattern through the recipe instructions. It presents recipe instructions one step at a time. For the cook, this design enables the single recipe step to be presented in large text and read across the kitchen and reduces distraction of surrounding instructions for the cook. For the researcher it builds on the "click-n-read" methodology developed by Ummelen (1997), to enable clear identification of which step was being read without the need for eye tracking technology.

6.2.5.2 Control Recipe Presentation on the iPad

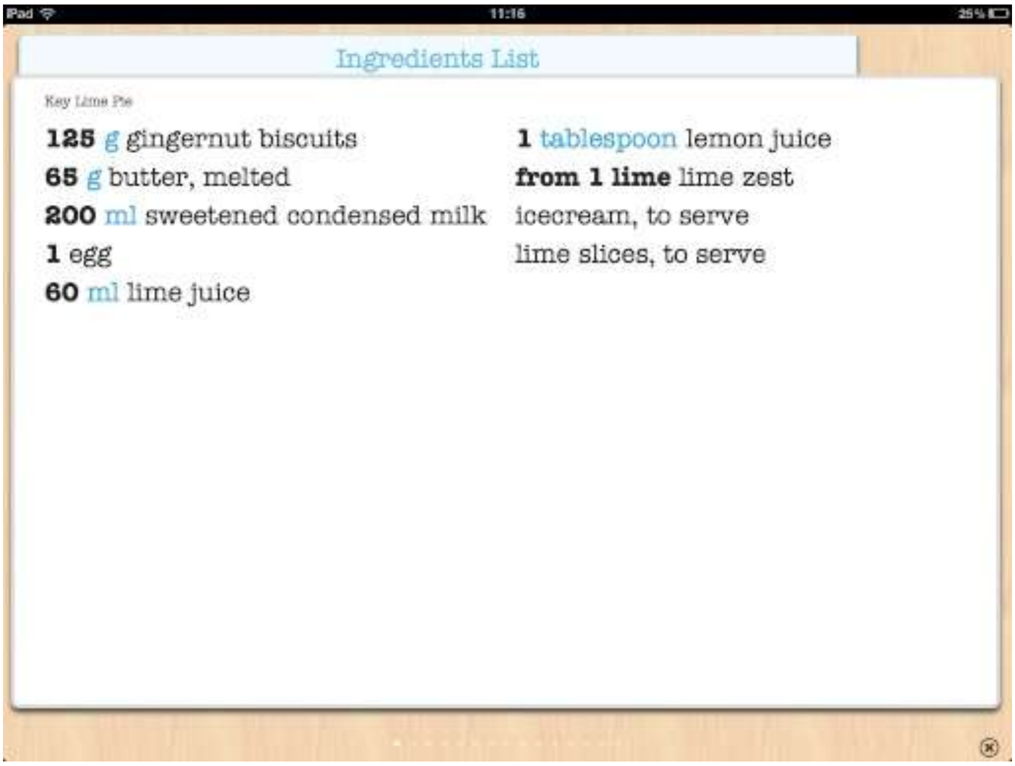

Figure 34: Ingredients list from Pie Recipe, Control Recipe Presentation

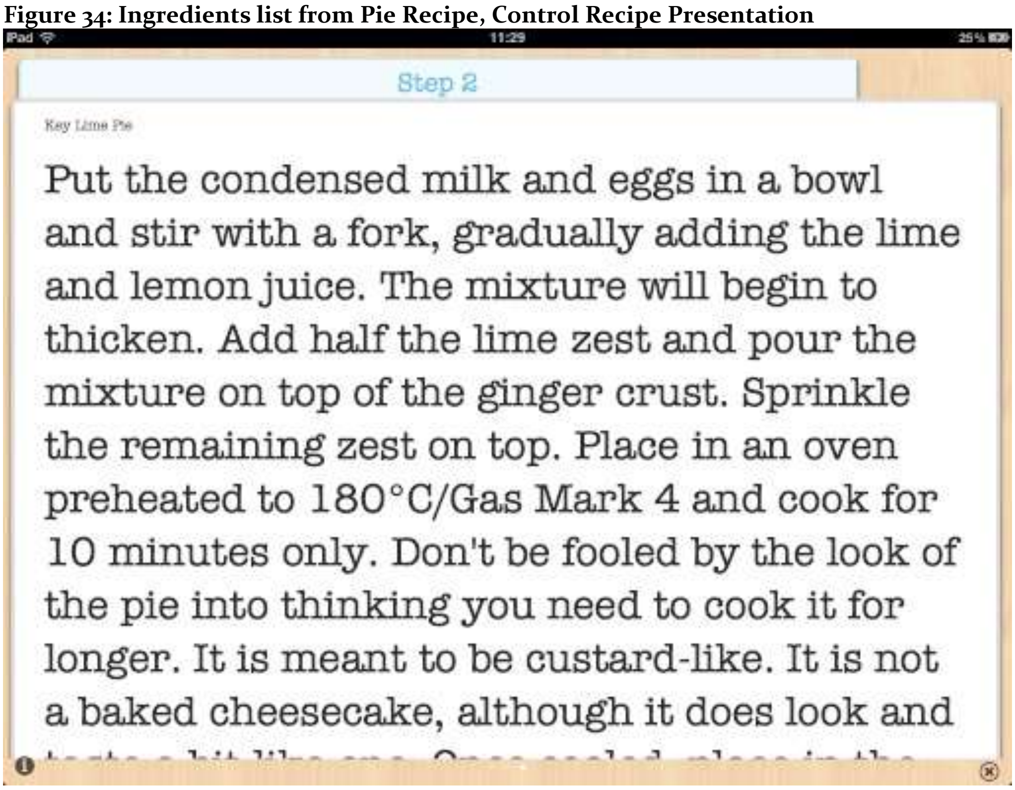

Figure 35: Step 2 from Pie Recipe, Control Recipe Presentation

In the **Control Recipe Presentation**, the recipe method instructions were presented as published in the original cookbook. Each numbered step or paragraph in the source recipe was presented as a single step in the method instructions. Figure 34 shows the ingredient list from the Control Recipe Presentation including the preparation instruction to melt the butter. Figure 35 shows step 2 from the Control Recipe Presentation. The step has 122 words and is too long to present on one screen. It contains references to four ingredients but, as it is presented in traditional recipe format, no quantities or preparation instructions are included.

6.2.5.3 Segmented Recipe Presentation on the iPad

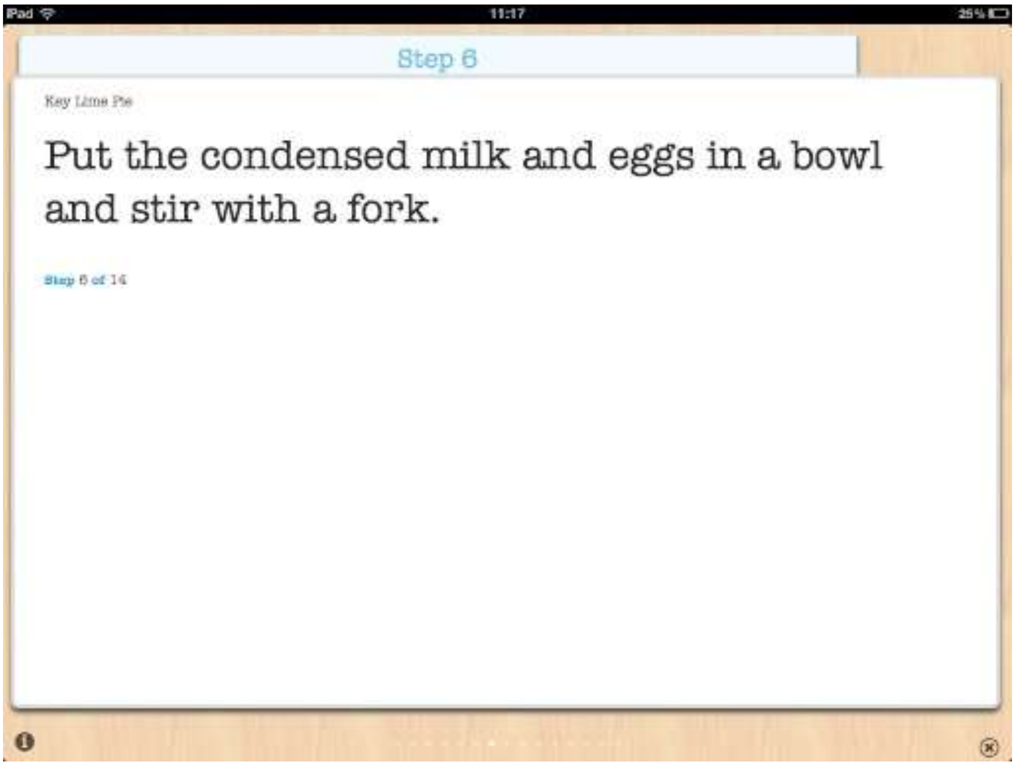

Figure 36: Step 6 from Pie Recipe, Segmented Recipe Presentation

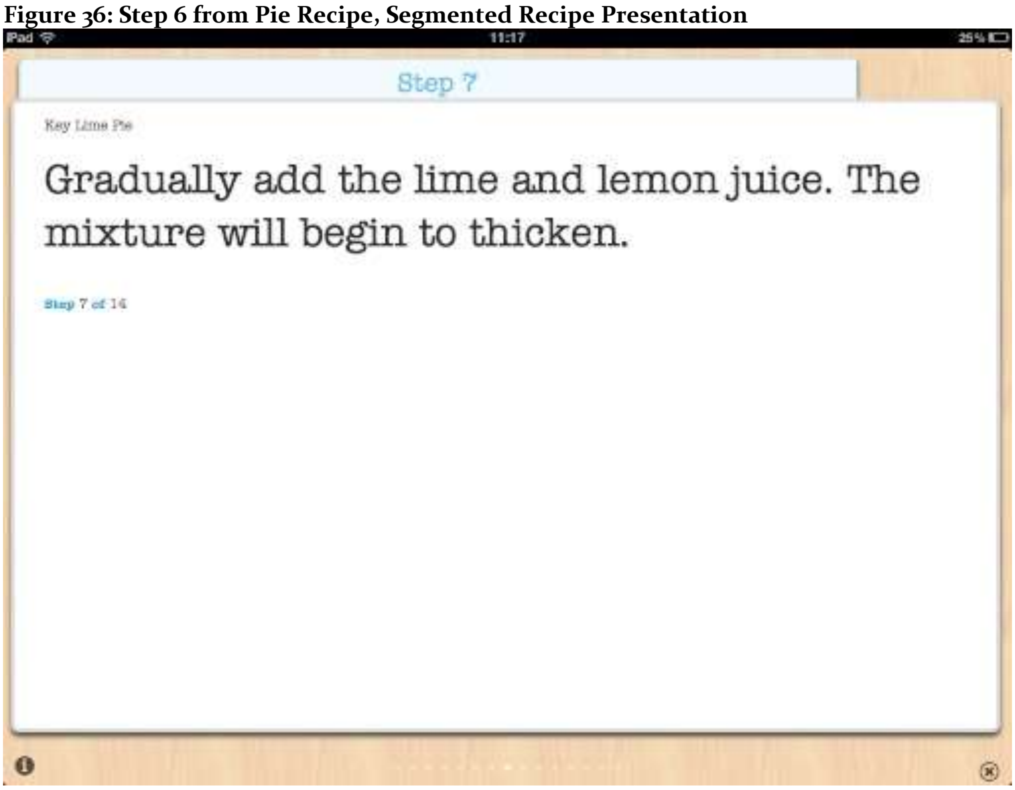

Figure 37: Step 7 from Pie Recipe, Segmented Recipe Presentation

In the **Segmented Recipe Presentation** the ingredients list was presented as in the Control Recipe Presentation and the method instructions were broken up into shorter steps so that each step contained a single task.

Figure 36 and Figure 37 show steps 6 and 7 of the Pie recipe in the Segmented Recipe Presentation. These represent the first two tasks that appear in step 2 of the Pie Recipe in the Control Recipe Presentation as shown in Figure 35.

Two analysts performed the process of segmenting the method instructions independently and the results were compared. The two analysts were in total agreement of the segmentation of two recipes. In the Recipe Pie they disagreed over the segmentation of three tasks. A total of 47 tasks were identified by each of the analysts across all the recipes. They disagreed on three tasks giving an overall inter-analyst agreement of 94%. After discussion both analysts were in full agreement.

6.2.5.4 Integrated Recipe Presentation on the iPad

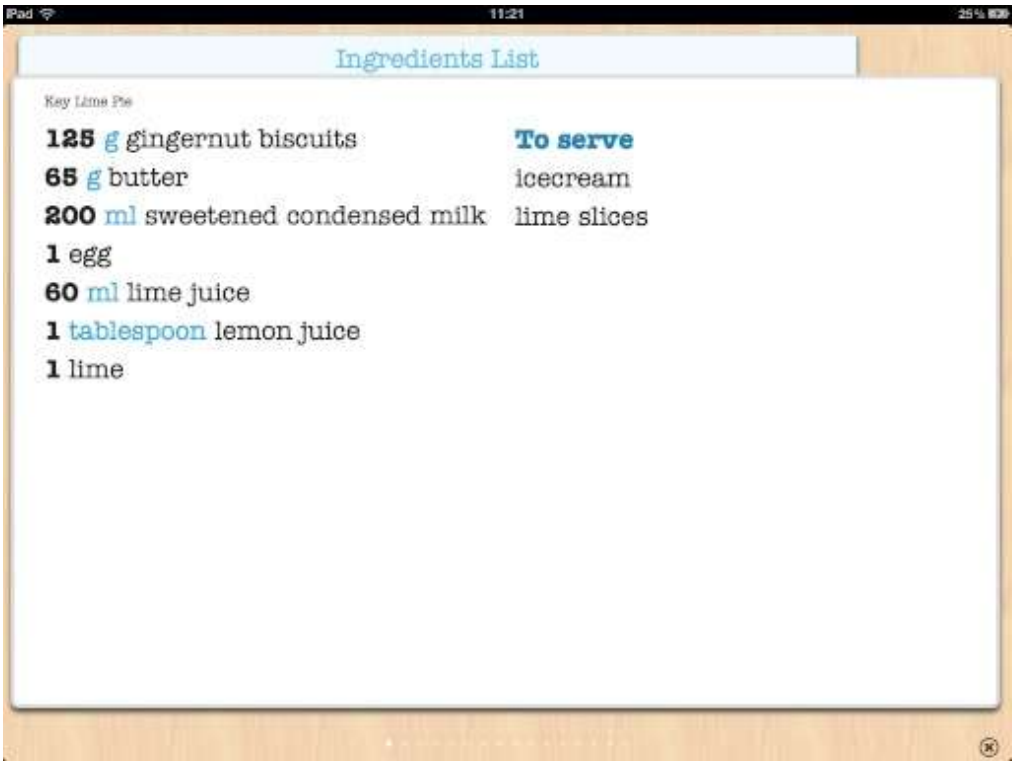

Figure 38: Ingredients list from Pie Recipe, Integrated Recipe Presentation

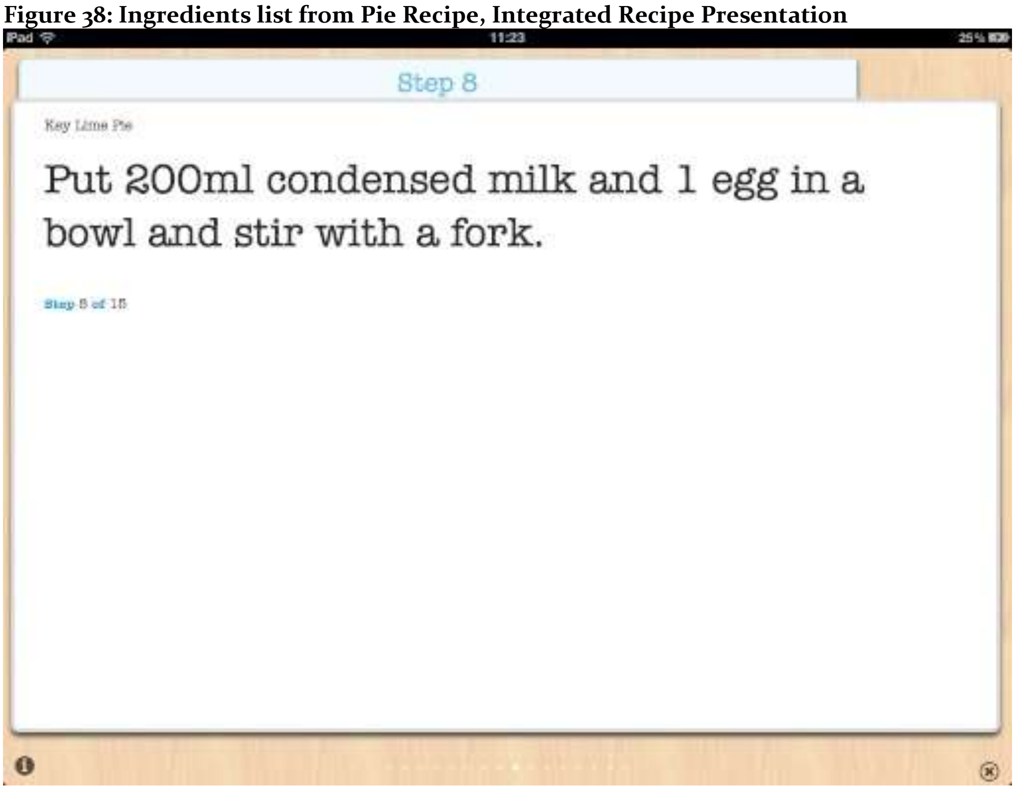

Figure 39: Step 8 from Pie Recipe, Integrated Recipe Presentation

In the **Integrated Recipe Presentation** the recipe method instructions were segmented as in the Segmented Recipe Presentation. Three further changes were made: (1) the preparation instructions were moved from the ingredient section to the method instructions; (2) the quantity of each ingredient was inserted into the text of the recipe step in which it was first mentioned and finally, where required, (3) an instruction was added to pre-heat the oven. Figure 38 shows the ingredient list from the Pie Recipe in the Integrated Recipe Presentation. Comparing this with the ingredient list in the control and Segmented Recipe Presentations (as seen in Figure 34), the preparation instruction to melt the butter has been moved to the method instructions. Figure 39 shows step 8 from the Pie Recipe in the Integrated Recipe Presentation. This step equates to step 6 of the method instructions in the Segmented Recipe Presentation (as seen in Figure 36) with the ingredient quantities inserted into the text.

6.2.5.5 Recipe adaptions for the study

The Dip Recipe comprised three distinct stages: soaking and cooking the beans, cooking the dip and finishing the dip with cheese and corn chips. The participants were asked to perform the middle stage only. They were provided with a can of ready to use beans to use when cooking the dip, and provided with cheese and corn chips with which they could finish the dip at home.

The Burgers Recipe comprised three distinct stages: preparing the burgers, chilling the burgers and cooking the burgers. The participants were asked to perform the first stage only. The lime zest was prepared in advance.

The Pie Recipe comprised three distinct stages: preparing the pie, baking the pie, serving the pie. The participants were asked to perform the first two stages. The measure Total Time to Complete was taken from the time they started to the time the pie went into the oven. The lime zest was prepared in advance.

6.2.5.6 Questionnaires

Participants' cooking experience questionnaire

At the start of the session the participants completed a questionnaire about their cooking skills and experience. The questionnaire was presented on paper and can be found in Appendix 4.

Post-cooking questionnaire

After each cooking session, participants were asked to complete a questionnaire. The first part contained questions about their experience with the recipe they had just prepared, the second part presented the standard System Usability Scale (SUS) questionnaire. The questionnaire was delivered using Morae which automatically associated their responses with the cooking session. The questionnaire can be found in Appendix 4.

6.2.6 Procedure

Participants attended one 3-hour session during which they were briefed, cooked three recipes with a break between each and were debriefed.

6.2.6.1 Briefing session

The briefing was provided verbally from a written checksheet. The participant was given a tour of the kitchen and shown where all the ingredients and utensils could be found. He or she was told the purpose of the study was to investigate the usability of the recipe application on the iPad and reassured it not a test of their cooking skills. The think aloud protocol was explained and he or she was asked to use it through the cooking session. They were encouraged to ask any questions about the recipe or kitchen at any time during the sessions.

After the briefing, the participant was asked to draw a numbered ball from a bag to randomly allocate their participant ID. This allocated them to one of the participant groups as seen in Table 23 that determined the order in which conditions were presented. The participant was given the printed copies of the recipes in appropriate conditions. They were asked to read them to familiarise themselves and highlight if they predicted any problems with ingredients or techniques.

The participant was then asked to sign the informed consent form, a copy of which can be seen in Appendix 4.

6.2.6.2 Cooking sessions

At the start of each cooking session the recipe display on the iPad was set to the ingredients page of the recipe and a Morae recording session was started.

During the cooking session the observer stayed in the kitchen with them to observe, answer any questions and prompt participants to use the think aloud protocol.

When each recipe was complete the recording was stopped and the cook was asked to complete the post-cooking questionnaire and to take a break.

6.2.6.3 De-briefing

After all three cooking tasks were completed the cooks were given a verbal debrief and the food they had prepared, packed up to take away. During the debrief they were told the purpose of the study was to investigate the effect of different presentation of recipe instructions on the time taken and the errors made.

6.2.7 Data preparation

Data was gathered from three sources: the Participants' cooking experience questionnaire, the Morae video recording of each cooking session and the associated Post-cooking questionnaires (including the SUS questionnaire). Data from the cooking experience questionnaire was captured on paper and later transcribed into an Excel spreadsheet for subsequent analysis. Data from the Post-cooking and SUS questionnaires was captured in Morae Recorder. A single score was calculated for each cook and recipe combination as described in "Measuring Usability with the System Usability Scale," (Sauro, 2011). The data preparation from the video recordings is described below.

6.2.7.1 Data preparation from video recordings

The video recording for each cooking session was imported into Morae manager. Each recording was coded for events and a transcript was created using timed markers through the video. The events coded were: start and end of the cooking session, start and end of each reading event, participants' interactions with the iPad (i.e. when swiped to next or previous step or onto the ingredient list), the recipe step visible on the iPad, cooking task activities, and transcript of utterances from both participant and observer. The coded markers were exported from Morae Manager and imported to an Excel spreadsheet for further data preparation.

Timed events

The Total Time to Complete the recipe was calculated from the timestamp of the start and end of the cooking session. The start of the cooking session was the time when the cook first looked at to read the recipe on the iPad. The end of the cooking session was the time when the cook completed the final task they were asked to perform. For the Pie Recipe this was when the pie went into the oven, for the Burgers Recipe this was when the burgers were placed in the fridge and for the Dip Recipe this was when the dip was poured into a serving vessel.

The Total Time Reading was calculated from the sum of the durations of all the reading events. The reading events were captured on the camera above the iPad. The start of a reading event was the time a cook looked at the iPad, the end when they looked away.

Progression maps

The route each participant took through the recipe instructions was visualised in a Progression Map. The concept of using Progression maps to show reading patterns was developed by Hornbaek & Frøkjaer (2003) to "show what parts of [the recipe that cooks] can see at which time in the reading process" (p.130).

The Progression Map was calculated from visible screen and the timestamps of the participants' interactions with the iPad. This data was captured on the camera pointed at the iPad.

Transcript and cooking activities narrative

The transcript and observations of cooking activities formed a narrative of the cooking session. This narrative was coded to identify the tasks being performed, errors made, problems experienced by the cook, and cooks' comments that might provide insight into their decisions.

6.3 Results

The results section is organised in five sections; (1) time to complete and read the recipe, (2) post-cooking questionnaire, (3) errors, (4) problems and (5) behaviours with implications for design.

6.3.1 Session interruptions

Of the 72 cooking sessions observed in this study, 7 sessions were interrupted. The total time to complete was adjusted for one session, as described below. No other data was adjusted as a result of the interruptions.

One session was interrupted as a result of a fire alarm drill. The cook was preparing ingredients and was able to pick up the task without hesitation when we returned to the kitchen. The total time to complete was adjusted; the time from the start of the alarm to the time the cook restarted work was subtracted from the total elapsed time to complete the recipe.

Six sessions were briefly interrupted due to the iPad application crashing. The application crashed during sessions where cooks prepared the Dip Recipe in the Integrated Recipe Presentation when they swiped through steps 23 or later in the recipe. For four cooks, the crash occurred while they were simmering the dish at the final stage of the recipe and they continued to observe the pot while the moderator restarted the application. For two cooks the crash occurred while they were performing tasks earlier in the recipe and the cooks tended to stirring the pot or tidying the workspace during the recover time. In each case the recovery time was less than 45 seconds and had no observable effect on the total time to complete the recipe. As a result no adjustments were made to the data as a result of the application crashing.

6.3.2 Time taken to complete and read the recipe

In order to investigate if there was an effect of Recipe Presentation on efficiency the time to complete and the time to read the recipes were compared.

6.3.2.1 Time taken to complete the recipe

The time taken to complete the recipe was captured from the video of the cooking session: the start was marked when the cook first looked at the iPad and the end when they completed the final task of the recipe.

Table 25: Mean total time taken to complete the recipe in seconds (SD)

Recipe Presentation /Recipe	Control	Segmented instructions	Integrated instructions	Overall
Pie	1,681 (415)	1,674 (432)	1,714 (541)	**1,690 (446)**
Burgers	1,543 (678)	1,446 (289)	1,515 (301)	**1,501 (441)**
Dip	2,739 (619)	2,718 (664)	2,979 (395)	**2,812 (560)**
Overall	**1,987 (779)**	**1,946 (732)**	**2,069 (776)**	**2,001 (754)**

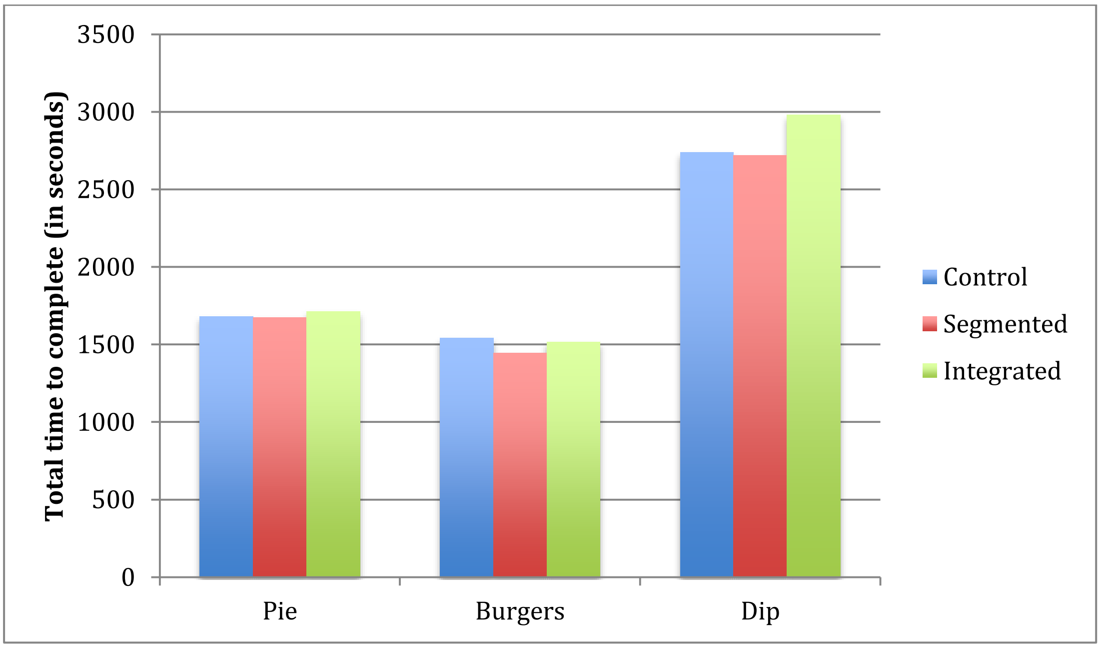

Figure 40: Total time to complete by Recipe and Recipe Presentation

Table 25 shows the mean time taken to complete the recipes by Recipe and Recipe Presentation. It is illustrated in Figure 40 and suggests the Dip Recipe took the longest to complete in all Recipe Presentations.

The data were submitted to a two-way ANOVA for several Latin squares with three levels of Recipe Presentation (Control, Segmented, Integrated) and three levels of Recipe (Dip, Burgers, Pie). The full model analysis was performed to account for interaction between Recipe Presentation and order of presentation (Cardinal & Aitken, 2005, p. 334).

The main effect of Recipe Presentation was not significant, $F(2,2)=.597$, n.s. The main effect of Recipe was significant, $F(2,2)=51.690, p=.019$. There was an interaction $F(4.36)=3.843$, $p=.011$. Post hoc comparisons using the Tukey HSD test indicated the mean time to complete the Dip Recipe (M=2812, SD=560) was significantly different than both the Burgers Recipe (M=1501, SD=441) and the Pie Recipe (M=1690, SD=446). The random effect of Participant was significant $F(22,40)=6.434$, $p=.000$.

The results show that the Dip recipe took longer to complete than the other recipes and the difference was most marked in the Integrated Recipe Presentation. Of all the recipes, the Dip Recipe had the highest number of preparation instructions. These results suggest that moving these to the start of the recipe might have altered when they were performed and therefore affected the total time to complete. This is explored further in section 6.3.6.5.

The ANOVA showed there was a variation due to participants. To investigate if this variation was due to individual differences of speed, i.e. if a cook was typically slow or typically fast in preparing recipes, the times to complete were ranked and the cooks in the fastest and slowest quartiles were compared.

Quartile	Cooks
1 (Fastest)	2 cooks for all 3 recipes
	3 cooks for 2 recipes & 1 recipe in Q2
4 (Slowest)	2 cooks for 3 recipes
	4 cooks for 2 recipes & 1 recipe in Q3

This suggests that some cooks were consistently slow in their preparation of recipes and others were consistently faster in their preparation. As this result may reflect the relative experience and skill level of cooks the cooking experience and frequency of using recipes (as described in 6.2.2.1) of the fastest two cooks and slowest two cooks was compared; there was no difference, all four cooks cooked everyday and used recipes two or three times a month.

6.3.2.2 Time taken to read the recipe

The time taken for each cook to read the recipe was the sum of all reading sessions noted on the video of the cooking session.

Table 26: Mean total reading time in seconds (SD)

Recipe presentation /Recipe	Control	Segmented instructions	Integrated instructions	Overall
Pie	179 (92)	169 (69)	155 (88)	**168 (80)**
Burgers	185 (94)	128 (47)	140 (56)	**151 (70)**
Dip	371 (143)	223 (77)	208 (94)	**268 (128)**
Overall	**245 (141)**	**173 (74)**	**168 (83)**	**196 (108)**

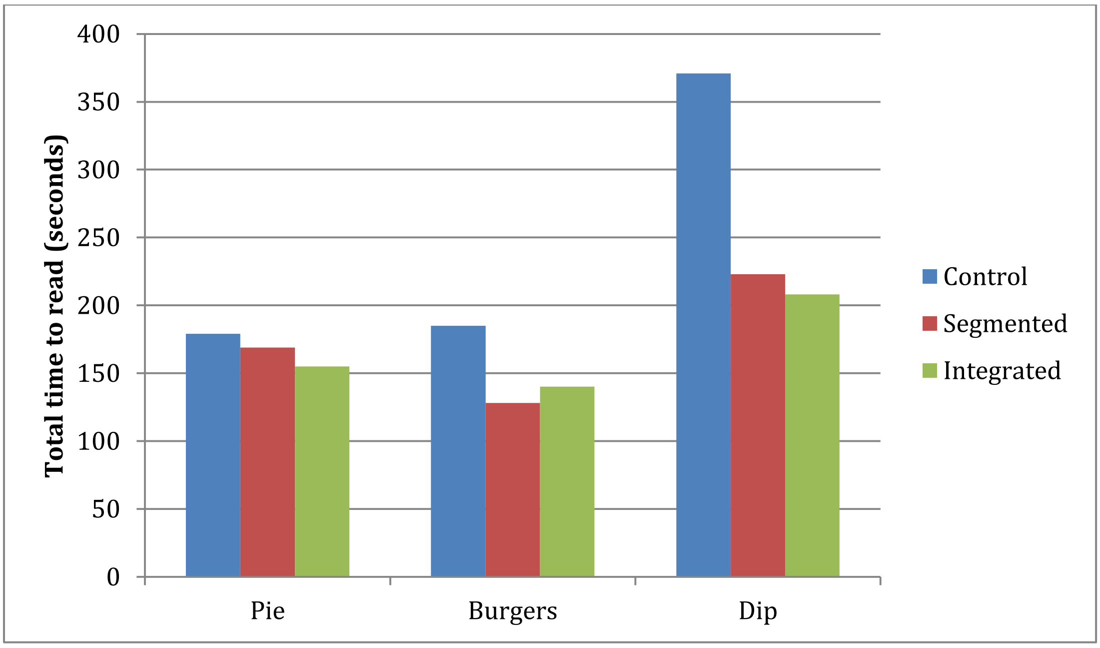

Figure 41: Mean total time to read in seconds

Table 26 shows the mean total reading time across all cooks, by Recipe and Recipe Presentation. It is illustrated in Figure 41 suggests that cooks took longer to read Recipes in Control Recipe presentation.

The data were submitted to a two-way ANOVA for several Latin squares as described in 6.3.2.1. The main effect of Recipe Presentation was not significant, F(2,2)=3.390, n.s. The main effect of Recipe was significant, F(2,2)=105.194, p=.009. There was no interaction between Recipe and Recipe Presentation, F(4,36)=0.608, n.s. The random effect of Participant was significant F(22,40)=6.952,p=.000

Post hoc comparisons using the Tukey HSD test indicated the mean time to read the Dip Recipe (M=268, SD=128) was significantly different than both the Burgers Recipe (M=151, SD=70) and the Pie Recipe (M=168, SD=80). No other significant differences were found.

6.3.3 Post-cooking questionnaire

In order to investigate the cooks' experiences with each Recipe and Recipe Presentation they were asked to complete a questionnaire after each cooking session.

6.3.3.1 Participant ratings: were the instructions clear?

Participants were asked to rate the clarity of the instructions on a 5-point scale where 5 was the highest rating and asked to add an optional comment.

Table 27: Were the instructions clear, mean ratings on scale 1-5 (SD)

Recipe presentation /Recipe	Control	Segmented instructions	Integrated instructions	Overall
Pie	4.25 (0.46)	4.50 (0.54)	4.88 (0.35)	**4.54 (0.51)**
Burgers	3.88 (0.64)	4.13 (0.64)	4.13 (1.13)	**4.04 (0.81)**
Dip	3.63 (0.92)	4.00 (1.07)	4.13 (0.64)	**3.92 (0.88)**
Overall	**3.92 (0.72)**	**4.21 (0.78)**	**4.38 (0.83)**	**4.17 (0.79)**

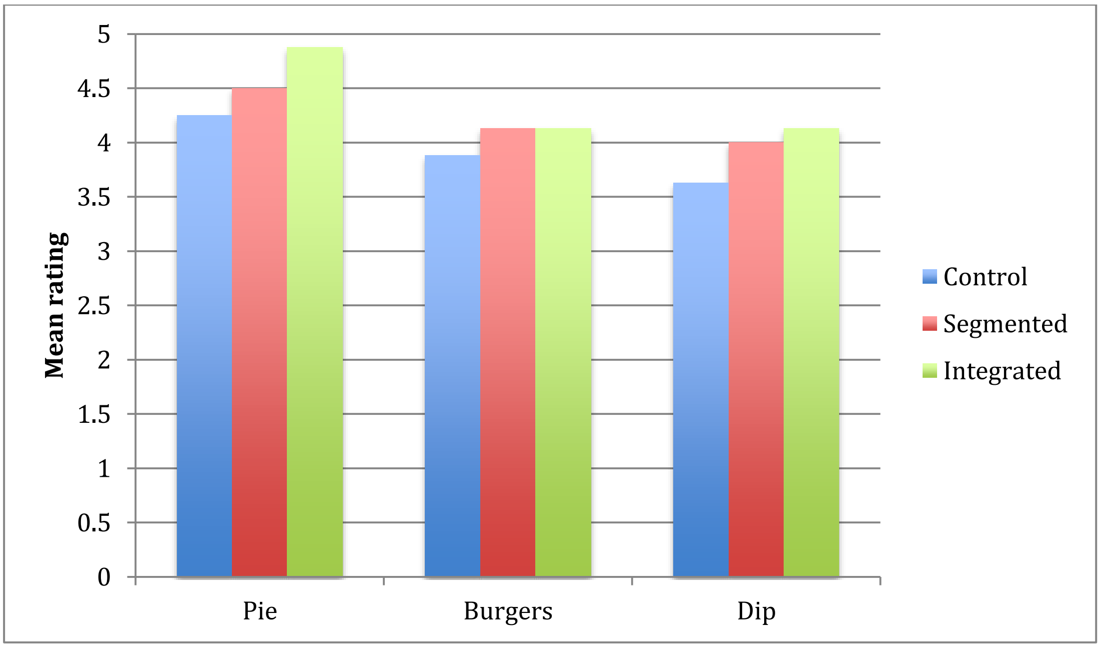

Figure 42: Were the instructions clear?

Table 27 shows the mean participant ratings for clarity of the recipe instructions by Recipe and Recipe Presentation. It is illustrated in Figure 42 and suggests that participants rated recipes in the Integrated Recipe Presentation higher than in other Recipe Presentations. The data was submitted to a two-way ANOVA for Latin squares.

The main effect of Recipe Presentation was significant, $F(2,2)=31.00$, $p=.031$. The main effect of Recipe was not significant, $F(2,2)=7.00$, n.s. There was no interaction between Recipe and Recipe Presentation $F(4,36)=0.391$, p=n.s. The random effect of Participant was significant, $F(22,40)=2.140$, $p=.018$.

Post hoc comparisons using the Tukey HSD test indicated the mean score for Integrated instructions Recipe Presentation (M=4.38, SD=0.83) was significantly different from Control Recipe Presentation (M=3.92, SD=0.72). However the Segmented instructions Recipe Presentation (M=4.21, SD=0.78) did not significantly differ from the Control or Integrated instructions Recipe presentations.

The results show that Integrated Recipe Presentation was rated clearer to read than the Control Recipe Presentation and the difference was most marked for the Pie Recipe. The lowest rating was for the Dip Recipe in the Control Recipe Presentation which also took the longest to read and the longest to perform which suggests the recipe was difficult to use.

There were 16 comments that mentioned the recipe wording was unclear, 10 of these were about the Dip Recipe, for example:

- Very ambiguous statements like ‘chop tomatoes’ (cook4)
- Sometimes not clear what I was meant to do exactly when it came to peppers and onions and tomatoes. [It] said ‘thinly sliced’ but I’d imagine that as sliced into circles when it seems what the recipe needed was ‘chopped’ or ‘diced’ versions of these (cook7)
- Also the recipe told me to ‘simmer rapidly’ at one point, which I was baffled by, since to me this seemed like an oxymoron (cook15)

A further 17 comments noted the need for more detail, e.g. “I hadn’t used lemongrass before so a bit of information on whether to peel it could have been useful" (cook16) and 7 comments were made about the order of instructions noting that, in the Pie Recipe, the instruction to heat the oven should come earlier in the method instructions.

6.3.3.2 Participant ratings: were the instructions easy to use?

Participants were asked to rate how easy the instructions were to use on a 5-point scale where 5 was the highest rating and asked to add an optional comment.

Table 28: Were the instructions easy to use, mean ratings on scale 1-5 (SD)

Recipe presentation /Recipe	Control	Segmented instructions	Integrated instructions	Overall
Pie	4.13 (0.84)	4.63 (0.74)	4.75 (0.46)	**4.50 (0.72)**
Burgers	3.88 (0.64)	3.88 (0.64)	4.13 (0.99)	**3.96 (0.75)**
Dip	3.75 (0.71)	3.88 (0.84)	4.63 (0.74)	**4.08 (0.83)**
Overall	**3.92 (0.72)**	**4.12 (0.80)**	**4.50 (0.78)**	**4.18 (0.79)**

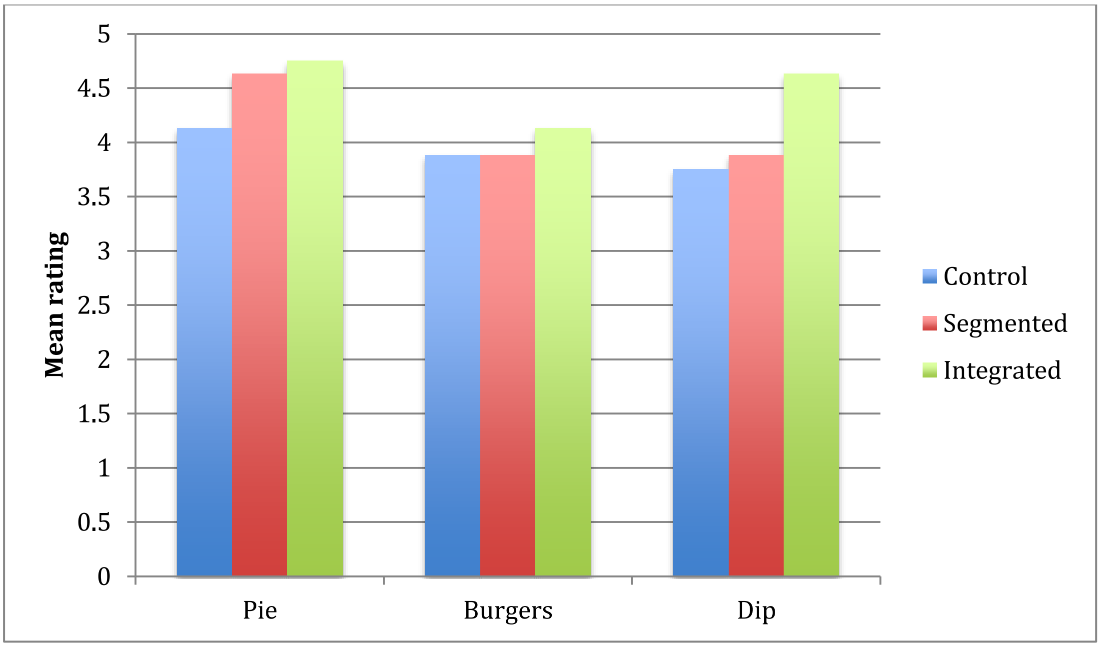

Figure 43: Were the instructions easy to use?

Table 28 shows the mean ratings for how easy the instructions were to use by Recipe and Recipe Presentation. It is illustrated in Figure 43 and suggests the participants rated the recipes easier to use in the Integrated Recipe Presentation.

The main effect of Recipe Presentation was significant, $F(2,2)=21.571$, $p=.044$. The main effect of Recipe was significant, $F(2,2)=19.857$, $p=.048$. There was no interaction between the Recipe and Recipe Presentation $F(4,36)=1.138$,n.s. The random effect of Participant was significant, $F(22,40)=3.947$, $p=.000$.

Post hoc comparisons using the Tukey HSD test indicated the mean score for Integrated instructions Recipe Presentation (M=4.5, SD=0.78) was significantly different from Control Recipe Presentation (M=3.92, SD=0.72). However the Segmented instructions Recipe Presentation (M=4.12, SD=0.80) did not significantly differ from the Control or Integrated instructions Recipe presentations.

Post hoc comparisons using the Tukey HSD test indicated the mean score for Pie Recipe (M=4.5, SD=0.72) was significantly different from Dip Recipe (M=4.08, SD=0.83) and from the Burgers Recipe (M=3.96, SD=0.75). However there was no significant difference between the Dip Recipe and the Burgers Recipe.

The results show that the ease of use rating varied among recipes and among Recipe Presentations. The lowest rating was given for the Dip Recipe in the Control Recipe Presentation. The effect of Integrated Recipe Presentation was most marked for the Dip Recipe in the Integrated Recipe Presentation. Combined with findings mentioned above, this indicates the Dip Recipe was the most difficult for the cooks but also the most improved by transforming the instruction design.

In the comments, cooks mentioned the reasons why recipes in the Control and Segmented Recipe Presentations were rated as less easy to use. Firstly, the individual recipe steps in the Control Recipe Presentation were considered too long, for example:

- Difficult to read as it was one solid block (cook11)
- Vast amount of text cluttered the screen and made it seem more complex than it actually was (cook23)

Secondly, there were more recipe steps in the Segmented Recipe Presentation and as a result they had to interact with the iPad more often to see the steps and in order to do this they had to wash their hands more often, for example:

- It is annoying to have to swipe to see the next stage, I like to be able to scan the next few steps as I am cooking (cook2)
- [It] means that sometimes you do things that you wouldn't if you could see a couple of steps ahead (cook2)
- It would be easier to have a couple of steps on one page…makes it easier to follow the instructions because you don't need to keep scrolling and cleaning your hands so you can touch the screen (cook21)

6.3.3.3 Participant ratings: would you make the recipe again?

Participants were asked to rate how likely they would be to make the recipe again on a 5-point scale where 5 was the highest rating and asked to add an optional comment.

Table 29: Would you make the recipe again, mean ratings on scale 1-5 (SD)

Recipe presentation /Recipe	Control	Segmented instructions	Integrated instructions	Overall
Pie	4.25 (.46)	4.38 (.52)	4.5 (.54)	**4.37 (.50)**
Burgers	4.25 (1.39)	3.75 (.89)	3.50 (.93)	**3.83 (1.09)**
Dip	3.13 (.64)	4.25 (1.04)	3.63 (1.30)	**3.67 (1.09)**
Overall	**3.88 (1.04)**	**4.13 (.85)**	**3.88 (1.04)**	**3.96 (.97)**

Table 29 shows the mean rating for "would you make the recipe again?" The main effect of Recipe Presentation was not significant, $F(2,2)=1.000$, n.s. The main effect of Recipe was not significant, $F(2,2)=2.548$, n.s. There was no interaction between the Recipe and Recipe Presentation $F(4,36)$,n.s. The random effect of Participant was not significant, $F(22,40)=1.094$, n.s.

Comments associated with this question indicate the cooks interpreted this question as being about the end product and most answered they would need to taste the dish before deciding to make it again, for example:

- Depends what it tastes like, but it was pretty easy, so if it turns out well, yes (cook6)
- If it tastes good then yes! It's a very easy recipe. (cook11)

6.3.3.4 Participant ratings: SUS

As part of the post-cooking questionnaire, participants were asked to complete the standard SUS questionnaire.

Table 30: Mean SUS scores (SD)

Recipe presentation /Recipe	Control	Segmented instructions	Integrated instructions	Overall
Pie	81.56 (8.12)	83.75 (7.20)	84.69 (9.68)	**83.33 (8.13)**
Burgers	84.06 (7.90)	85.31 (5.74)	85.94 (8.01)	**85.10 (7.01)**
Dip	84.69 (7.72)	82.50 (12.03)	83.75 (13.75)	**83.65 (10.98)**
Overall	**83.44 (7.69)**	**83.85 (8.43)**	**84.79 (10.31)**	**84.03 (8.78)**

Table 30 shows the mean SUS score calculated from responses to the standard SUS questionnaire. The data were submitted to a two-way ANOVA for Latin squares.

The main effect of Recipe Presentation was not significant, $F(2,2)=0.881$, n.s. The main effect of Recipe was not significant, $F(2,2)=0.428$, n.s. There was no interaction between the Recipe and the Recipe Presentation, $F(4,36)=1.079$, n.s. The random effect of Participant was significant, $F(22,40)=3.269$, $p=.001$. Considering the results from the SUS questionnaire and the feedback from cooks during the debrief sessions, the questionnaire did not prove an appropriate measure for the usability or usefulness of the interactive recipes in this study.

6.3.3.5 Missing information

Participants were asked to indicate if there was any additional information they would like in the recipe. The comments were categorised by content and counted by category.

Table 31: Missing information comments

Recipe Presentation/ Comment category	Control	Segmented	Integrated	Total
No missing information	11	8	5	**24**
Content	2	2	4	**8**
Ingredient quantities in step	1	3	2	**6**
Pictures	1	0	4	**5**
Two instructions on one page	0	1	0	**1**
Total	**15**	**14**	**15**	**44**

Table 31 shows counts of categorised comments about information missing in the recipes. The question was optional and only 44 responses out of a potential 72 were recorded. The table shows that, of the potential 72 responses, cooks made only 20 (27%) comments about missing information.

With regards the missing information in the content, cooks mentioned timing, technique, yield and detail. For example cook 21 said "It would be nice to get information on the consistency and maybe texture of the food in the making, depending on the step you are at" about the Burgers Recipe in Integrated Recipe Presentation.

With regards the ingredient quantities cooks said they wanted the ingredient quantities in the steps or visible on the same page, for example cook 1 said "yes, it is better to include the quantity of the ingredients required in the instructions on iPad" of the Burgers Recipe in Segmented Recipe Presentation.

With regards pictures cooks said they wanted pictures of the end product and at key stages, for example cook 23 said "I'd have really liked a photograph (possibly at key stages) to know what I should be aiming for. I didn't know whether or not the dish was ready, or how small things should be chopped" of the Dip Recipe in Integrated Recipe Presentation.

Cook 16 explained that having two instructions on the same page would reduce the problem of swiping the iPad with mucky hands: "At the part where the mixture must be blended with the hands, the next two instructions should be on one page because by this point the hands are covered in meat and the cook does not know what to do next. Luckily I had already thought to look at the next instructions so I didn't have this problem but other people might" of the Burgers Recipe in Segmented Recipe Presentation.

6.3.4 Errors performed by cooks

To investigate the accuracy with which cooks followed instructions, the transcripts were analysed to identify when they performed tasks in error and the errors were then categorised by source of information; measure or task.

Table 32: Mean errors performed by cooks in a single recipe by Presentation and type of error

Recipe Presentation/ Error theme	Control	Segmented instructions	Integrated instructions	Mean
Incorrect measures	0.46 (.7)	0.65 (1.2)	0.57 (.9)	**0.56 (.9)**
Performed instruction incorrectly	1.25 (2.3)	1.7 (2.4)	0.86 (1.3)	**1.22 (2.0)**
Other	0.63 (2.0)	1.05 (2.0)	0.11 (.6)	**0.54 (1.6)**
MEAN	**0.78 (1.8)**	**1.13 (1.9)**	**0.51 (1.9)**	**0.77 (1.6)**

Table 32 shows the most frequent type of error performed by cooks related to measuring ingredients. The data were submitted to ANOVA[9]. There was no effect of Recipe Presentation, $F(2,2) = 1.937$, n.s. There was no effect of error theme $F(2,2) = 3.12$, n.s. and there was no interaction $F(2,180) = .468$, n.s.

Considering the type of errors that cooks made, on 34 occasions cooks made no attempt to measure the ingredient they were adding to the mixture. For example they poured the olive oil directly into the frying pan or emptied the can of beans into the saucepan. Other measurement errors included occasions when cooks measured the ingredient correctly then decided to add some more because there was some left in the package. Only one instance was observed where a cook miscounted the number of measures to make up a correct measure – they counted 3 x 15ml to make up a 60ml measure.

Cooks were observed to perform instructions incorrectly on 40 occasions. The most common error of this type was observed in cooks preparing the Dip Recipe. The recipe instructed that the onion and pepper should be thinly sliced but 26 cooks chopped them into small pieces. The definition of chopping[10] and slicing[11] were taken from the BBC Good Food website. Other errors included selecting the incorrect cooking vessel, for example a frying pan instead of a saucepan, and adding ingredients all at once when the instruction said to add them gradually.

Cooks' comments associated with the errors indicated that for some cooks, the errors were performed knowingly, for example:

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[9] Data were also submitted to Friedman's two-way ANOVA by ranks for nonparametric data, ignoring recipe and matching cooks. No effect of Recipe Presentation was found

[10] http://www.bbc.co.uk/food/techniques/dicing_onions

[11] http://www.bbc.co.uk/food/techniques/slicing_onions

> "so I'm making fine slices of this, so chopping it thinly. It doesn't say chopped but in fact it means chopped. You'll say in a second it does actually mean sliced and I'll have problems but that's OK, it's a dip. There are worse things you can mess up than a dip [laughs]" (cook 24)

Others became aware of their error later in the preparation and provided a post-facto justification, for example:

> "Cos I see the pepper and the onion they are not, like, it would be good if they were fried, so I chose a frying pan, although it says a saucepan" (cook 7).

6.3.5 Problems encountered by cooks

To investigate the problems that cooks experienced when following the recipes, the transcripts were analysed to identify when cooks said they were confused or unsure how to proceed. The problems were organised into three themes based on the source of the problem: recipe content, implementation, and cooks' knowledge or confidence. Problems were further organised within these themes.

Table 33: Mean problems per cook by Recipe and Recipe Presentation (SD)

Recipe Presentation/Recipe	Control	Segmented instructions	Integrated instructions	Mean
Dip	6.25 (3.7)	3.38 (2.3)	5.5 (5.5)	**5.04 (4.1)**
Burgers	3.13 (3.2)	3.38 (3.2)	2.63 (1.5)	**3.04 (2.5)**
Pie	3.25 (1.5)	1.50 (2.4)	1.33 (1.2)	**2.00 (1.7)**
MEAN	**4.21 (3.1)**	**3.00 (2.7)**	**2.89 (3.5)**	**3.36 (3.2)**

Table 33 shows problems encountered by cooks by Recipe and Recipe Presentation. It suggests that more problems were encountered by cooks preparing the Dip recipe than other recipes and by more cooks using the recipes in the Control Recipe Presentation than in other presentations, the data were submitted to ANOVA[12]. There was no effect of Recipe Presentation F(2,2) = 1.474, n.s., there was no effect of Recipe F(2,2)=4.295, n.s., there was no interaction F(4,36)=2.286, n.s. There were no other significant results. Post-hoc comparisons using Tukey's HSD test suggested that Dip Recipe was associated with more problems than either the Burgers or Pie Recipe.

Table 34: Total count of problems encountered by cooks organised by Recipe Presentation and by theme

Recipe Presentation/ problem theme	Control	Segmented instructions	Integrated instructions	TOTAL
Recipe content	73	37	50	**160**
Cooks' knowledge/ confidence	15	19	16	**50**
Implementation	12	12	8	**32**
TOTAL	**100**	**68**	**74**	**242**

Table 34 shows the problems encountered by cooks organised by theme and Recipe Presentation. The table suggests that recipe content was the most common source of problems encountered by cooks. The data was submitted to ANOVA[13]. There was no effect of Recipe Presentation F(2,2)= 2.531, n.s., there was no effect of problem theme F(2,2)= 5.082, n.s., there was no interaction F(4,36)=2.117, n.s. There were no other significant effects. Post-hoc comparisons using Tukey's HSD indicated there were more problems related to recipe content than to cooks' confidence or implementation.

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[12] Data were also submitted to Friedman's two-way ANOVA by ranks for nonparametric data, ignoring recipe and matching cooks. No effect of Recipe Presentation was found

[13] Data were also submitted to Friedman's two-way ANOVA by ranks for nonparametric data, ignoring recipe and matching cooks. No effect of Recipe Presentation was found

Problems relating to recipe content

To investigate if the count of problems varied between Recipes or Recipe Presentations, the problems relating to recipe content were further broken down.

Table 35: Mean problems per cook due to recipe content by Recipe and Recipe Presentation (SD)

Recipe Presentation/Recipe	Control	Segmented instructions	Integrated instructions	Mean
Pie	2.63 (1.4)	0.75 (1.5)	1.08 (1.0)	**1.54 (1.4)**
Burgers	1.25 (1.6)	1.25 (1.3)	1.13 (0.8)	**1.21 (1.2)**
Dip	5.38 (3.3)	2.13 (1.6)	4.25 (4.1)	**3.92 (3.3)**
MEAN	**3.08 (2.8)**	**1.5 (1.5)**	**2.0 (206)**	**2.22 (2.5)**

Table 35 shows the problems experienced due to recipe content by Recipe and Recipe Presentation. The data were submitted to ANOVA[14]. There was no effect of Recipe Presentation $F(2,2) = 8.486$, n.s. There was no effect of Recipe $F(2,2)=4.331$, n.s. there were no other effects. There was an interaction $F(4,180) = 10.808$, $p=.000$. Post-hoc tests using Tukeys HSD indicated there were more problems in the Control Recipe Presentation than in the Segmented Recipe Presentation.

Within the problems relating to recipe content, six sub-themes were identified. Counts and examples of problems in these are expanded below.

[14] Data were also submitted to Friedman's two-way ANOVA by ranks for nonparametric data, ignoring recipe and matching cooks. No effect of Recipe Presentation was found

Table 36: Total count of problems relating to content by sub-theme, with examples

Sub-theme	Count of problems	Characteristic problem
Confusing content	34	"Simmer rapidly" is a very odd phrase. How can you simmer at any speed other than simmering? (Dip, cook 2)
		it just says chop [tomatoes] now that could mean anything. I guess it doesn't say finely so that's kind of a give away (Dip, cook 9)
Information available but not where needed	33	And we also need chicken, how much chicken do we need? The recipe should remind us of how many we should use at a certain point. It's the recipe really. I can't fault the software (Burgers, cook 15)
		Oh shit! I didn't pre-heat the oven, oh brilliant! (Pie, cook 9)
Missing information	32	Chopped fresh coriander [laughs] now it doesn't specify if you chop all the coriander or just the leaves. There's quite a distinction (Burgers, cook 20)
		It's not giving me any clues as to the size of the thing I'm going to be making but I'm assuming it's not going to be big so I don't want a huge bowl in there (Pie, cook 11)
Interpreting instruction	28	How do I know if the liquid is evaporated? It is impossible right because sauce has a lot of liquid (Dip, cook 8)
Instructions mismatch with real world	19	is it 200 grams or 200 ml? (Pie, cook 8) [recipe says 200ml, package is labelled in grams]
Instructions don't adapt to circumstances	14	[recipe says can use canned beans to substitute for dried beans but step 1 tells cooks to cook the dried beans]
		So should I cook them [beans] according to the instructions? The kidney beans for 25 or 30 minutes it says? (Dip, cook 4)
TOTAL	**160**	

Table 36 shows examples of problems related to recipe content, organised and counted by sub-theme. The table shows the most common problem related to confusing content where cooks found the wording ambiguous or counter-intuitive. Cooks also had problems with locating information they needed. In some cases that information was missing from the recipe, for example the size of bowl or saucepan needed, and in some cases the information was contained with the recipe but not available in the instruction when it was needed.

Problems relating to implementation design

Cooks experienced two main problems in relation to the implementation of the recipes. Fourteen cooks mentioned problems with interactions with interacting with the iPad. The main problem was that they had to swipe the iPad to move between instructions and this required them to have clean and dry hands. As a consequence they washed and dried their hands many times during the recipe presentations and this frustrated them, for example

- "I think what's inconvenient with the iPad is you get dirty fingers while cooking and you don't want to swipe it" (cook 8)

Eleven cooks mentioned problems with recipes in the Control Recipe Presentation because of the amount of content on the screen, for example:

- "too much text…it's very difficult to read lots of text like that" (cook 11)

Problems relating to cooks' knowledge or confidence

To investigate if problems relating to cooks' knowledge and confidence varied by Recipe the problems were broken down further.

Table 37: Mean problems per cook relating to cooks' knowledge or confidence by Recipe and Recipe Presentation (SD)

Recipe Presentation/ Recipe	Control	Segmented instructions	Integrated instructions	Mean
Pie	0.38 (.5)	0.75 (1.0)	0.25 (.5)	**0.38 (.6)**
Burgers	1.00 (1.3)	1.38 (1.4)	1.13 (.6)	**1.17 (1.1)**
Dip	0.5 (.8)	0.5 (.5)	0.63 (1.0)	**0.54 (.8)**
MEAN	**0.63 (.9)**	**0.9 (1.1)**	**0.61 (.8)**	**0.69 (.9)**

Table 37 shows the count of problems relating to cooks' knowledge and confidence organised by Recipe and Recipe Presentation. The table suggests that cooks had more problems when preparing the Burgers recipe but that problems were experienced evenly across all Recipe Presentations, the data were submitted to ANOVA. There was no effect of Recipe Presentation $F(2,2)=2.771$, n.s, there was an effect of Recipe $F(2,2)=203.4$, $p=.005$. There was an interaction $F(4,180) = 9.631$, $p=.000$. Post-hoc comparisons using Tukeys' HSD indicated there were more problems with the Burger Recipe than either the Dip or Pie Recipe.

The most common problems experienced related to lack of knowledge and familiarity with ingredients such as lemongrass (used in the Burger Recipe) and passata (used in the Dip Recipe). The Burgers Recipe also presented problems with the terms "patty" (to mean burger shaped) and "crush" (instruction to prepare the garlic clove). Cooks had not encountered these terms before and did not know what they meant.

Only three cooks mentioned problems due to lack of confidence, one cook mentioned the problem in each recipe. He was particularly concerned with preparing onions, a task that featured in both the Dip and Burgers Recipe, for example:

- “now there is a way [to chop onions] but, I’m really bad at this so don’t judge me” (cook 9)

6.3.6 Behaviours with implications for design

To investigate cooks’ behaviours that might have implications for design, cooks’ reading patterns were visualised and their task flow was analysed.

6.3.6.1 Reading patterns

The reading pattern of each cooking session was visualised in a progression map as described in section 6.2.7.1 Technical problems with the camera that recorded the iPad resulted in unusable data for three cooking sessions thus there were only six progression maps for the Dip Recipe in Segmented Recipe Presentation and only seven progression maps for the Burger Recipe in Integrated Recipe Presentation.

Three modes of interaction were identified on the progression maps which indicate how the cooks read through and used the content in the recipes: linear read-through, ingredient look-up and look-aheads. The modes are illustrated in the sections below with counts and comments from cooks.

6.3.6.2 Linear read-through

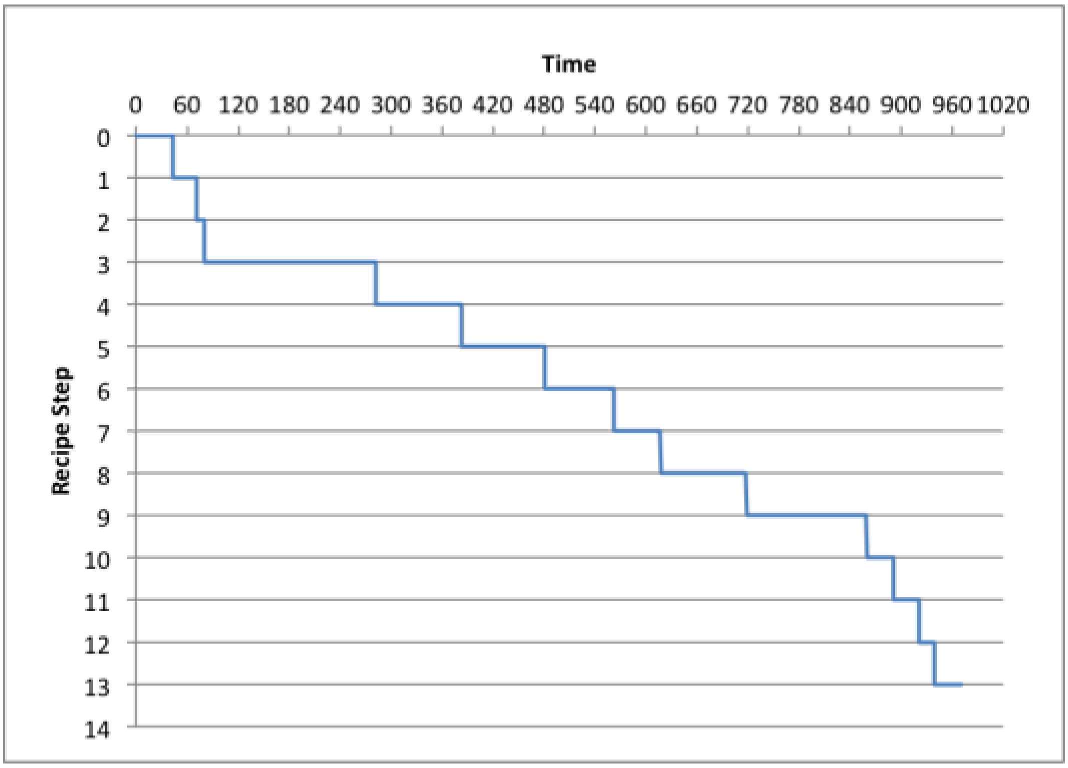

Figure 44: Progression map of cook 17 preparing Pie recipe showing the linear read-through mode

The linear read-through mode was identified when cooks read each recipe step in order and at no time moved backwards or forwards in the recipe. Figure 44 shows the reading pattern progression map of cook 17 preparing the Pie Recipe in Integrated Recipe Presentation. The vertical axis indicates the recipe steps with step zero representing the ingredient list. The cook started reading the ingredients list and then read each recipe step in turn.

The linear read-through mode was observed in only three cooking sessions and in all of which the recipe was in the Integrated Recipe Presentation.

6.3.6.3 Ingredient look-ups

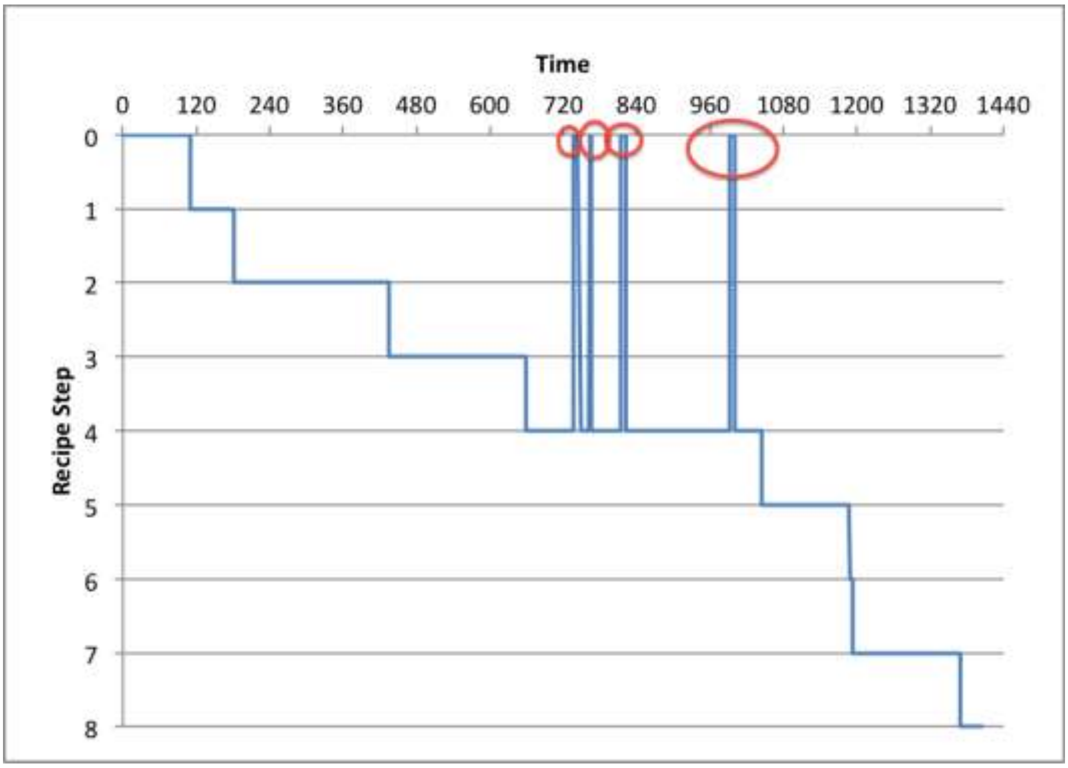

Figure 45: Progression map of cook 2 preparing the Burgers recipe showing the ingredient look-up mode

The ingredient look-up mode was observed when cooks switched from reading a recipe step to reading the ingredient list and then back to the recipe step. Figure 45 shows the reading pattern progression map of cook 2 preparing the Burgers Recipe in Segmented Recipe Presentation. The cook started reading the ingredient list, then read through steps 1-4. While on step 4 at about 740 seconds, the cook switches to the ingredient list on four occasions, indicated by red circles. Each of these is termed an ingredient look-up.

Count of ingredient look-ups per cooking session

To investigate if there was an effect of Recipe or Recipe Presentation on the count of ingredient look-ups in a cooking session, the progression map for each cooking session was inspected and ingredient look-ups counted.

Table 38: Count of ingredient look-ups per cooking session (SD)

Recipe Presentation/ Recipe	Control	Segmented instructions	Integrated instructions	Mean
Pie	6.13 (1.8)	4.63 (1.9)	0.13 (0.4)	**3.62 (3.0)**
Burgers	4.13 (2.4)	2.63 (1.7)	0.57 (0.8)	**2.52 (2.2)**
Dip	4.63 (2.5)	4.67 (3.2)	2.62 (2.1)	**3.91 (2.6)**
MEAN	**4.96 (2.3)**	**3.91 (2.4)**	**1.13 (1.7)**	**3.35 (2.7)**

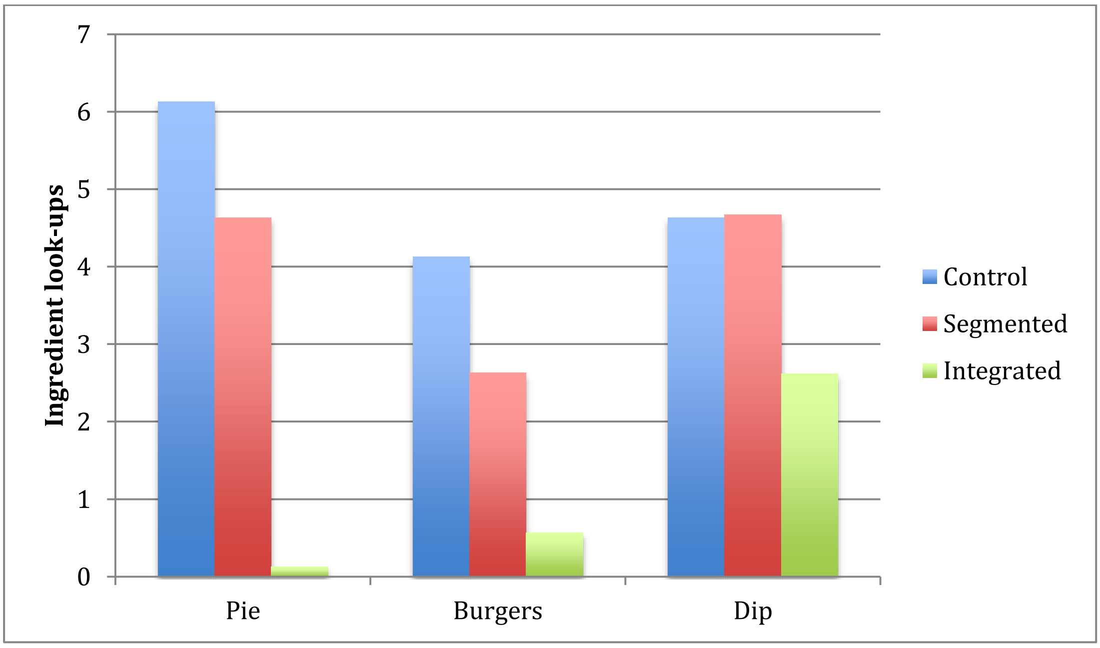

Figure 46: Ingredient look-ups per cook

Table 38 shows the mean count of ingredient look-ups per cooking session by Recipe and Recipe Presentation. It is illustrated in Figure 46. This suggests there were fewer ingredient look-ups when the cook was preparing a recipe in the Integrated Recipe Presentation. This was expected because the ingredient quantities were included in the text of the method instructions, negating the need to switch to the ingredient list for this information. The data was submitted to a two-way ANOVA for Latin squares.

The main effect of Recipe Presentation was significant $F(2,2)=101.572$, $p=.010$. The main effect of Recipe was not significant, $F(2,2)=5.715$, n.s. There was no interaction between Recipe and Recipe Presentation, $F(4,33)=.672$, n.s. The random effect of participant was significant, $F(22,37)=2.600$, $p=.005$. This suggested the cooks took different approaches to looking up ingredients. Some looked up each individual ingredient, others switched attention to the ingredient list and measured several ingredients at a time. Considering individual cooks, no pattern of behaviour emerged across the recipes.

Post hoc comparisons using the Tukey HSD test indicated the count of ingredient look ups in the Integrated instructions Recipe Presentation (M=1.13, SD=1.7) was significantly different from the Segmented instructions (M=3.91, SD=2.4) and the Control (M=4.96, SD=2.3).

Cooks' comments about ingredient look-ups

In order to investigate the reason why cooks performed the ingredient look-ups, the time stamp for each was noted and the transcript of the cooking session was inspected at that time. The comments made by cooks at the time of the ingredient look-up confirmed that on most occasions they were looking for the quantity of an ingredient mentioned in the method instruction step, for example:

- Just going back to see how much garlic there was (cook18)
- Right, how much lemongrass do we want? (cook16)

On a few occasions cooks used the ingredient list as a checklist of ingredients to assemble, for example:

- I'm just working out what ingredients I haven't put in. Done chicken and breadcrumbs, done onion, done garlic, done coriander. I need lime zest, done the coriander, lime zest, fish sauce and sugar (cook14)

The comments illustrate why the count of look-ups varied across cooks. Some cooks looked up every ingredient while others switched to the ingredient list and added several ingredients at a time.

6.3.6.4 Look-aheads

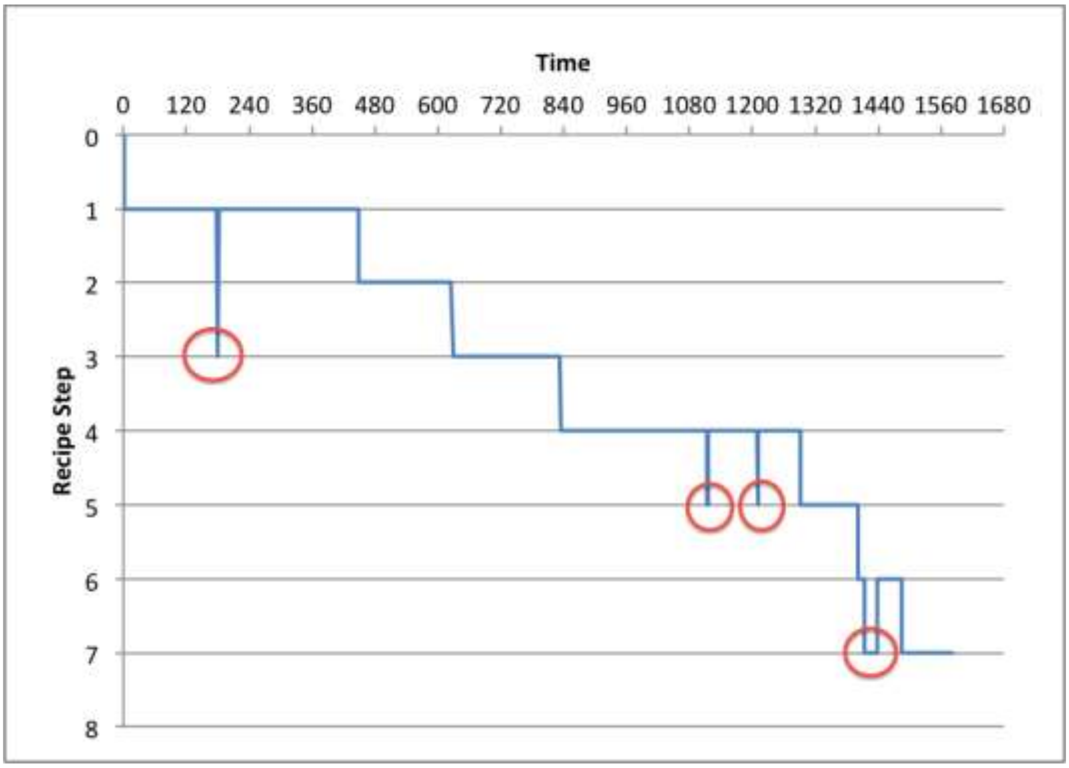

Figure 47: Progression map showing look-ahead mode

A look-ahead was observed when a cook switched from reading the current recipe step to a future one and then switched the view back to the current step. Cooks performed look-aheads over 1, 2 or more steps before returning to the current step. Figure 47 shows the reading pattern progression map for cook 1 preparing the Burgers Recipe in the Segmented Recipe Presentation. The cook looked ahead in the recipe on four occasions through the cooking session, each indicated with a red circle.

Count of look-aheads per cooking session

To investigate if there was an effect of Recipe or Recipe Presentation on the count of look-aheads in a cooking session, the progression map for each cooking session was inspected and look-aheads counted.

Table 39: Mean count of look-aheads per cooking session (SD)

Recipe Presentation/ Recipe	Control	Segmented instructions	Integrated instructions	Mean
Pie	1.38 (1.2)	4.00 (2.1)	0.87 (0.8)	**2.08 (2.0)**
Burgers	0.50 (0.5)	1.00 (1.4)	2.00 (1.9)	**1.13 (1.5)**
Dip	2.00 (1.9)	5.00 (3.3)	4.25 (1.9)	**3.64 (2.6)**
MEAN	**1.29 (1.4)**	**3.18 (2.8)**	**2.39 (2.1)**	**2.26 (2.3)**

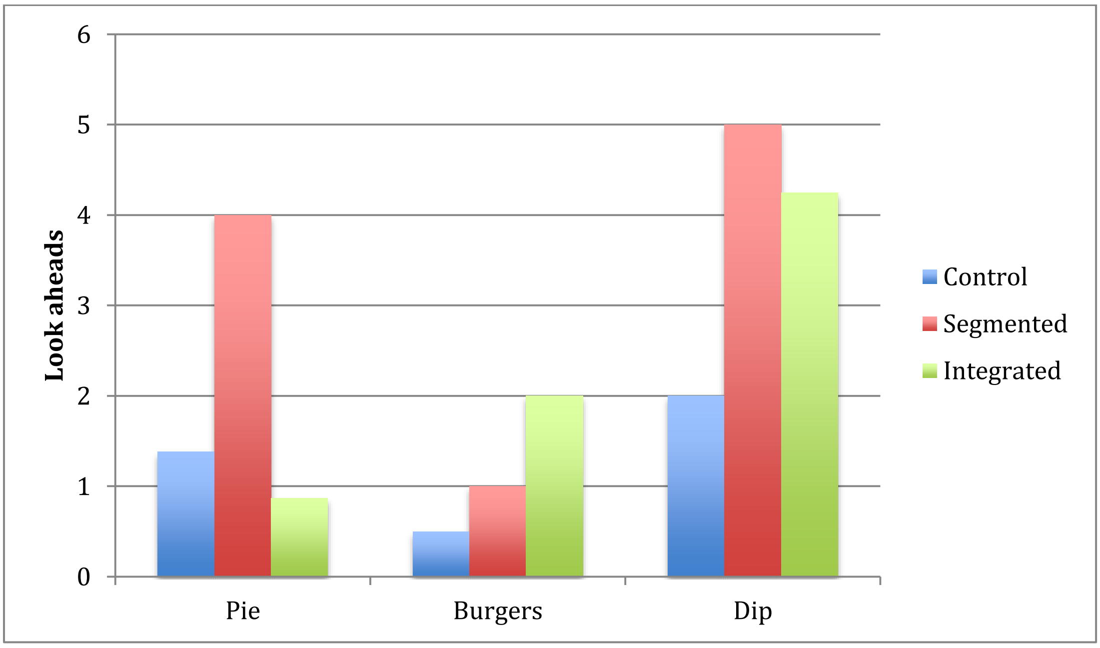

Figure 48: Count of look-aheads per cook

Table 39 shows the mean count of look-aheads per cooking session by Recipe and Recipe Presentation. The table and Figure 48 suggest that cooks performed look-aheads more often in the Dip Recipe than in the other recipes and suggested that cooks may have performed more look-aheads in recipes in Segmented Recipe Presentation than in other Recipe Presentations. The data was submitted to a two-way ANOVA for Latin square.

The main effect of Recipe Presentation showed a trend towards significance $F(2,2)=14.414$, $p=.065$. The main effect of Recipe was significant, $F(2,2)=109.084$, $p=.009$. The interaction showed a trend towards significance $F(4,33)=2.369$, $p=.073$. The random effect of participant showed a trend towards significance, $F(22,33)=1.855$, $p=.053$.

Post hoc comparisons using the Tukey HSD test indicated the count of look aheads in the Segmented Recipe Presentation ($M=3.18$, $SD=2.1$) was significantly different from the Control Recipe Presentation but not different from Integrated Recipe Presentation.

Post hoc comparisons using the Tukey HSD test indicated the count of look aheads in the Dip Recipe ($M=3.64$, $SD=2.6$) was significantly different from the Burger Recipe but not different from Pie Recipe.

The results suggest that segmentation of instructions increases the count of look aheads a cook performs in some recipes although it is not clear why.

Cooks' comments about look-aheads

In order to investigate the reason why cooks performed look-aheads, the time stamp for each was noted and the transcript of the cooking session was inspected at that time. 105 comments were retrieved in this way and the content analysed for emergent themes.

Table 40: Cooks' comments about look-aheads

Theme	Count	Characteristic comment
Looking for a task to perform in parallel	35	I was just seeing if there is anything I can be doing while the butter is melting. It's nice to be efficient (Cook 12)
Reading ahead	27	I'm just looking ahead to see what happens next (Cook 18)
Has query about goal state of ingredient	10	Not sure what it means by thinly sliced, thinly sliced into what? I mean if it's a dip then it must be, erm, see what is it doing at the end of it (Cook 7)
Has query about size of utensil to use	7	I am just trying to think, to see what happens after this because I think that pan is going to be a bit too big (Cook 17)
Others	26	OK, I'll read through the… (cook 21) What shall I start with? Onion? (cook 6)
TOTAL	**105**	

Table 40 shows the cooks' comments about look-ahead behaviour. The most frequent reason for cooks to look-ahead was to find a task to perform in parallel (35 comments). Cooks also looked ahead to answer queries about the current step, either about the goal state of the ingredient they were working on or to select the correct size of utensil (e.g. a bowl or saucepan) for future steps.

6.3.6.5 Planning task order for Preparation instructions

In order to investigate how cooks incorporated tasks from the preparation instructions into the overall preparation of the recipe, the order in which they performed tasks was plotted for each cooking session.

Summary of cooks' mise-en-place activity

The sections above describe how a few cooks performed *partial mise-en-place* activities as they prepared the recipes. Table 41 shows a summary of the counts of cooks who performed the *partial mise-en-place*. The table shows that cooks performed a *partial mise-en-place* in fewer than 10% of the cooking sessions.

Table 41: Summary of cooks' mise-en-place activity

Recipe Presentation/ Recipe	Control	Segmented	Integrated	Total
Pie	1	0	1	**2**
Burgers	0	0	0	**0**
Dip	3	2	0	**5**
Total	**4**	**2**	**1**	**7**

Recipes in Control Recipe Presentation

Table 42 shows the order in which cook 3 performed the preparation instructions, up to and including the first method instruction step. Note for the Dip Recipe, step 1 refers to preparing the dish with dried beans. In this study cooks were provided with canned beans so they did not perform step 1.

Cook 3 performed all the vegetable preparation instructions before starting the first task in the method instructions but not in the order presented in the ingredient list. Cook 3 did not measure any of the other ingredients or crumble the feta cheese. Two other cooks were observed to share this pattern of tasks when preparing the Dip Recipe in Control Recipe Presentation.

Only one preparation instruction was included in the ingredients list of the Burgers Recipe Presentation; “1tbsp finely chopped coriander”. The instructions to grate the onion and chop the garlic were included in step 1 of the method instructions. Every cook prepared at least the onion and garlic and added them to the mixing bowl before preparing the coriander leaves. No cook measured out ingredients before starting the method instructions.

Table 42: Task order as performed by Cook 3 for Dip Recipe in Control Recipe Presentation

Recipe wording (task order)	Task order as performed by Cook 3	
50 g dried black beans	1	take 1/2 red pepper
1 tbsp. olive oil (11)	2	finely slice pepper
1/2 small red pepper (1), deseeded and thinly sliced (2)	3	take 1 red onion
1 small red onion (3), thinly sliced (4)	4	finely slice onion
1 tsp. ground cumin	5	take 1 chilli
1 garlic clove (7), finely chopped (8)	6	finely chop chilli
2 tomatoes (9), chopped (10)	7	take 1 garlic
1 small red chilli (5), finely chopped (6)	8	finely chop garlic
1 tbsp. red wine vinegar	9	take 2 tomatoes
125 ml passata	10	chop tomatoes
100 g feta cheese, crumbled	11	measure 1tbsp olive oil
to serve corn chips	12	add oil to pan
	13	heat pan
METHOD:	14	add pepper to pan
1. Soak the black beans in cold water overnight...	15	add onion to pan
2. Heat the oil in a saucepan (12,13) set over high heat and add the red pepper (14) and onion (15). Reduce the heat to low, cover and cook for about 8 minutes. Add the cumin, garlic and chillies and cook for a further 2 minutes. Add the beans, tomatoes, vinegar and passata and bring to the boil. Reduce the heat and simmer rapidly for 10 minutes, until almost all the liquid has evaporated and the tomatoes start to look mushy.		

Only one preparation instruction was included in the ingredients list of the Pie Recipe; “65g butter, melted”. The butter was referred to in step 1 of the method instructions:

> *“1. Crush the biscuits by putting them in a plastic bag and pounding them with a rolling pin until powdery. Transfer them to a bowl and add the melted butter. Stir well, then place in the base of a small pie tin and pat into place.”*

One cook melted the butter before staring the method instructions, the others interspersed monitoring the melting butter (either in a saucepan or microwave) while they pounded the biscuits. This illustrated how cooks integrated information from the ingredient list and method instructions and created an action plan.

The results show that no cooks performed a complete *mise-en-place* before starting the method instructions. Three cooks, including cook 3 illustrated above, using the Dip Recipe prepared the vegetable ingredients but did not measure out the other ingredients or prepare the feta cheese. They performed a *partial mise-en-place*.

Recipes in Segmented Recipe Presentation

Table 43 shows the pattern followed by cook 19 and five other cooks. They prepared the onion, and pepper before starting the method instructions and prepared the garlic, chillies and tomatoes once the onion and pepper were frying. Two cooks prepared all vegetable ingredients before starting the method instructions.

Cooks preparing the Burgers Recipe and the Pie Recipe followed the same pattern as those preparing the recipes in the Control Recipe Presentation. No cook measured ingredients ahead of starting the method instructions.

Table 43: Task order as performed by Cook 19 for Dip Recipe in Segmented Recipe Presentation

Extract of Recipe text with (task order)	Task order as performed by Cook 19	
50 g dried black beans	1	take 1 red onion
1 tbsp. olive oil (6)	2	finely slice onion
1/2 small red pepper (3), deseeded and thinly sliced (4)	3	take 1/2 red pepper
1 small red onion (1), thinly sliced (2)	4	finely slice pepper
1 tsp. ground cumin	5	take 1 chilli
1 garlic clove (15), finely chopped (16)	6	measure 1tbsp olive oil
2 tomatoes (17), chopped (18)	7	add oil to pan
1 small red chilli (5), finely chopped (8,10,13)	8	finely chop chilli
1 tbsp. red wine vinegar	9	heat pan
125 ml passata	10	finely chop chilli
100 g feta cheese, crumbled	11	add onion to pan
to serve corn chips	12	add pepper to pan
	13	finely chop chilli
.....	14	cover & cook 8 mins
8. Heat (9) the oil in a saucepan (7) set over high heat.	15	take 1 garlic
9. Add the red pepper (12) and onion (11).	16	finely chop garlic
10. Reduce the heat to low.	17	take 2 tomatoes
11. Cover and cook for about 8 minutes. (14,19)	18	chop tomatoes
12. Add the cumin, garlic (20) and chillies (21).	19	cover & cook 8 mins
13. Cook for a further 2 minutes.	20	add garlic to pan
14. Add the beans, tomatoes, vinegar and passata.	21	add chilli to pan
....		

The results show that no cooks prepared a full *mise-en-place*. Two cooks prepared the vegetable ingredients in the Dip Recipe before starting the method instructions; they performed a *partial mise-en-place*.

Recipes in Integrated Recipe Presentation

Preparation instructions were relocated to the method instructions for recipes in the Integrated Recipe Presentation. When making the Pie Recipe, one cook measured the condensed milk and lime juice before starting the method instructions. No other cook using any recipe measured or prepared any ingredients before starting the method instructions.

6.3.6.6 Parallel task handling

To investigate if cooks performed tasks in parallel the task order was plotted and inspected for instances where cooks alternated between tasks. The most frequent parallel task handling instances were found in the Pie Recipe when the cooks were making the pie base and in the Dip Recipe when cooks were cooking the onion and pepper for 8 minutes. These are expanded below. Cooks did not perform parallel tasks when making the Burgers Recipe.

Table 44: Parallel task handling - Cook 5 preparing Pie Recipe in Control Recipe Presentation

Recipe tasks and task order								
Measure biscuits	**Measure butter**	**Melt butter**	**Crush biscuits**	**Transfer to bowl**	**Add butter**	**Stir**	**Shape base**	**Notes**
1								Cook starts to measure biscuits and then says "I think at this moment I better start the butter melting"
	2							
		3						Cook puts butter into microwave and says "right, now back to biscuits"
4								Cook puts another two biscuits on scale and then checks microwave
		5						Cook sets another 20 seconds on microwave
6								Cook says "So we just needed to set the butter again to melt cos it wasn't very melty, back to the biscuits"
		7						
8								
			9					
				10				
		11						Cook checks butter again and sets another 10 seconds on microwave
					12			
						13		
			14					Cook says "I don't think I mashed the biscuits up enough really"
							15	

Table 44 shows the order of tasks performed by cook 5 when making the Pie Recipe in Control Recipe Presentation. The cook starts measuring the biscuits and then says "I think at this moment I better start the butter melting". He stops measuring biscuits to measure the butter and start it melting. He measures the biscuits in parallel with monitoring the butter melting in the microwave.

Table 45: Frequency of cooks performing tasks in parallel in Pie Recipe

Recipe Presentation/ Mode of performing tasks	Control	Segmented	Integrated	Total
Performed in parallel	6	1	0	**7**
Performed in serial	2	7	8	**17**
TOTAL	**8**	**8**	**8**	**24**

Table 45 shows that 7 (29%) of cooks melted the butter while measuring and/or crushing the biscuits, however they were not evenly spread across the Recipe Presentations. Only 25% of cooks using the recipe in Control Recipe Presentation performed the task in serial compared to 88% in the Segmented Recipe Presentation and 100% in the Integrated Recipe Presentation. The results suggest that shorter instruction steps alter the way that cooks perform tasks.

Parallel task handling in Dip Recipe

Step 2 of the Dip Recipe in Control Recipe Presentation is shown below. The majority of cooks performed some tasks in parallel with the "cook for about 8 minutes".

*2. Heat the oil in a saucepan set over high heat and add the red pepper and onion. Reduce the heat to low, cover and **cook for about 8 minutes**. Add the cumin, garlic and chillies and cook for a further 2 minutes. Add the beans, tomatoes, vinegar and passata and bring to the boil.*

Table 46: Frequency of cooks performing tasks in parallel in Dip Recipe

Recipe Presentation/ Mode of performing tasks	Control	Segmented	Integrated	Total
Chopped ingredients in parallel	3	4	0	**7**
Measured ingredients in parallel	5	4	4	**13**
No tasks performed in parallel	0	0	4	**4**
TOTAL	**8**	**8**	**8**	**24**

Table 46 shows that 20 (83%) of cooks performed either measuring or preparation tasks such as chopping ingredients in parallel with the onions and peppers cooking however they were not spread evenly over the Recipe Presentations. 100% of the cooks using the recipe in the Control Recipe Presentation and 100% of the cooks using the recipe in the Segmented Recipe Presentation performed tasks in parallel compared to only 50% of the cooks using the recipe in the Integrated Recipe Presentation.

The results suggest that, when given the opportunity to plan their own task order, cooks make use of cooking time to perform other tasks in parallel. The cooks did not have the option to plan their own task order in the Integrated Recipe Presentation because all the preparation instructions were moved to the start of the method instructions.

6.4 Discussion

In this study 24 cooks prepared three recipes presented in three different formats: Control (traditional Recipe Presentation), Segmented instructions and Integrated instructions. The study was designed to address the research questions: (1) how do cooks interact with recipe instructions (2) how do segmented instructions affect cooks and (3) how do integrated instructions affect cooks.

6.4.1 Cooks' interactions with recipes in Control Recipe Presentation

Recipes in the Control Recipe Presentation were presented in the traditional recipe format, i.e. as they were published. The recipes had ingredient information and preparation instructions listed in the ingredient list and the method instruction steps were of mixed length, some short and some long enough that the cook had to scroll the page to read the end.

Considering the feedback given in the post-cooking questionnaire cooks rated recipes in the Control Recipe Presentation significantly lower than recipes in the Integrated Recipe Presentation for ease of use and clarity of instruction. They said the length of some recipe steps were like a "wall of text" (cook 14), "difficult to read" (cook 11) made an instruction "seem more complex than it actually was" (cook 23). These comments support those by Gibbs Ostmann and Baker (2001) and Whitman (1993) that method instructions in long paragraphs are problematic for cooks.

Considering the task flow of cooks at the start of the recipe, only four cooks performed a partial mise-en-place. That is, they assembled most of the ingredients, they performed the preparation instructions but they did not measure the ingredients that did not have a preparation instruction. The other 20 cooks assembled some of the ingredients and then measured and prepared them interspersed with performing tasks described in the method instruction steps. As the information was split across the recipe cooks had to switch attention between the method instruction step and the ingredient list on average 4.96 times per recipe.

In addition to switching attention between the method instructions and the ingredient list, cooks also switched attention from the current step to future steps on average 1.29 times per recipe. Cooks looked ahead when waiting for a mixture to cook, for example when the pepper and onions were cooking for 8 minutes in the Dip Recipe, and described their behaviour as "I'm just looking ahead to see what happens next" (cook 8). Taking both ingredient look ups and look-aheads together, cooks switched attention around the recipe more than 6 times during the preparation of the dish.

Considering the task flow of cooks while preparing the recipe, cooks performed tasks in parallel with each other. For example, in the Pie Recipe cooks melted the butter in parallel with crunching the biscuits and in the Dip Recipe cooks measured and prepared ingredients while the onions and peppers were cooking. In both recipes, the cook initiated a task that did not need constant attention, e.g. butter melting in the microwave or saucepan, and the cook then filled the time with other tasks. In both cases cooks elaborated tasks in the instructions and formed a mental plan to perform some tasks in parallel.

This behaviour pattern of cooks has not previously been identified in the interactive recipe systems literature. Most of the early interactive recipe systems, for example *PersonalChef* (Mennicken et al., 2010) made design assumption that cooks would perform tasks in sequence and presented method instructions in sequence to support this assumption. The one system, HappyCooking (Hamada et al., 2005) designed to support parallel tasks in order to optimise time to prepare recipes, provided the plan for parallel tasks but did not evaluate either the system or the plan against cooks performing the recipes without the system as support. As a result it is not clear if their algorithm for calculating the plan or the system presenting the plan was useful and effective.

Cooks reported more than four problems in each recipe. Most of the problems (66%) related to the content of the recipe, i.e. the wording. For example the instruction to "simmer rapidly" was confusing because the two words appeared in conflict with each other (to simmer is to cook at a very gentle boil[15]), and the instruction to "chop" the tomatoes was ambiguous because the cook did not know whether to chop roughly or finely. A further 21% of problems were because they lacked experience with ingredients or techniques. For example, few cooks had prepared lemongrass (used in the Burgers Recipe) before taking part in the study and were unsure if they should peel it before following the preparation instruction.

Culinary terms in recipes are known to cause problems for inexperienced cooks (Stead et al., 2004) and this problem has been the motivation for the design and development of some early interactive recipe systems such as *PersonalChef* (Mennicken et al. 2010). When writing recipes it is important to know your audience, what their experience and knowledge levels are (Gibbs Ostmann and Baker, 2001), however, with the growing number of online recipe libraries, cooks are now exposed to recipes written for many different audiences. The recipes selected for this study were drawn from general cookbooks, not specifically aimed at the demographic of the participants. In describing the early interactive recipe systems, few researchers described the source of their recipe content (Uriu et al., 2012 was an exception) so it is not clear if the recipes were specifically aimed at the demographic of their participants. In addition, none of the previous research reported problems in detail. As a result, it is not clear if their results are generalizable to a wider range of recipes or participants.

The most common error performed by cooks was performing a task

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[15] http://whatscookingamerica.net/Information/PoachingSimmeringBoiling.htm

incorrectly such as chopping instead of slicing. Some cooks indicated that they were fully aware that they were performing task differently and asserted that they were right and the recipe was wrong, others gave no indication that they were aware of their error. As a result it was not possible to analyse the errors in terms of slips and mistakes (Reason, 1990). The next most common error was failure to measure ingredients, for example pouring oil directly into a frying pan without measuring. Taken together, the types of errors performed suggest that cooks did not value accuracy in following the recipe.

The findings show that cooks do not mise-en-place and they find large blocks of text difficult to read. They do not follow instructions sequentially and they perform tasks in parallel. This shows that the traditional format of recipe does not support cooks in how they work and it would be useful to investigate if other designs of recipe instructions provide better support.

6.4.2 Cooks' interactions with recipes in Segmented Recipe Presentation

Recipes in the Segmented Recipe Presentation were different from those in the Control Recipe Presentation in one way: the method instruction steps were broken into shorter, segmented steps with one task per step.

Considering that cooks did not like the long paragraphs in recipes in the Control Recipe Presentation, it was surprising that they did not rate the recipes in the Segmented Recipe Presentation any higher in terms of clarity or ease of use. This was a surprising result because research from instruction design suggests that shorter steps are easier to follow than those presented in longer paragraph steps (Duggan and Payne, 2001; Ganier, 2004). However, in this study the method instructions were presented one step per page and the cook had to swipe to move between the steps. This may have been a factor in the keeping the ratings low because this additional work frustrated cooks when their hands were mucky with ingredients and they had to wash and dry their hands in order to swipe the iPad. For example cook 16 said "the next two instructions should be on one page because at this point the hands are covered in meat and cook does not know what to do next".

Considering the task flow of cooks at the start of the recipe, only two cooks performed a partial mise-en-place. The other cooks, as with those using recipes in the Control Recipe Presentation, assembled some of the ingredients and then measured and prepared them in parallel with performing tasks in the method instructions. As with cooks using recipes in the Control Recipe Presentation, cooks switched attention from method instruction steps to the ingredient list to obtain ingredient quantities and preparation instructions. They performed ingredient look-ups at the same frequency as cooks using the Control Recipe Presentation.

These findings show, for this group of participants at least, that cooks do not routinely prefer to assemble and prepare ingredients as assumed by Tomlinson (1986) and Gibbs Ostmann and Baker (2001). They suggest that a separate ingredient list creates additional work for the cook while preparing the recipe because they have to switch attention between instruction and ingredient list and integrate the information.

In addition to switching attention to the ingredient list, cooks also looked ahead at future instructions and they did it more often than cooks using recipes in the Control Recipe Presentation. Cooks looked ahead in the recipe firstly to find tasks to perform in parallel and secondly to find information to help them understand the current instruction step. One problem experienced by cooks was in interpreting instructions such as "chop tomatoes" if they did not know how the tomatoes would be used later in the recipe. For example, cook 7 said "how finely are these chopped up? [looked ahead] it's a dip so probably very fine". Another problem was in deciding what size of saucepan or bowl to select. They looked ahead in the recipe to find out how large the mixture later in the procedure, for example cook 17 said "I'm still a little unsure about this pan usage because I am not sure how big it will be but I think worst comes to the worst I can just put it in that one, switch it round".

With regards problems, findings showed a trend towards fewer problems experienced with recipes in the Segmented and Integrated Recipe Presentations compared with those in the Control Recipe Presentation. The findings support those of Duggan and Payne (2001) that shorter steps are easier to follow, although it is not clear how this reduces the problems related to the text in the recipes. The findings provide further support that the short recipe steps used in the early interactive recipes systems were a factor in their success.

The findings suggest that cooks do not treat the method instructions steps as independent stand alone instructions, rather they used instructions later in the recipe as context to help them interpret earlier instructions. This has implications for design of interactive recipe systems. Firstly it shows that presenting individual recipe steps, i.e. one step per page, whilst removing distraction of other steps, introduces a new problem by removing the context of the overall procedure. Secondly it suggests that highlighting the narrative of ingredients through the method instructions would benefit cooks by reducing their search space as they look ahead.

6.4.3 Effects of integrated instructions

Recipes in the Integrated Recipe Presentation were designed so all the information needed to complete the recipe was included in the method instructions, i.e. all the information needed from the ingredients list was also integrated into the method instructions. The method instructions were presented as short steps, segmented as they were in the Segmented Recipe Presentation.

Considering the feedback in the post-cooking questionnaires, cooks rated recipes in the Integrated Recipe Presentation easier to use and clearer to read than recipes in the Control Recipe Presentation but not significantly different from those in Segmented Recipe Presentation. As shown above, shorter method instruction steps introduced frustration for cooks who had to swipe the iPad more often than in the Control Recipe Presentation. This suggests that integrating information from the ingredients list into the method instructions, was the primary factor in cooks rating recipes in the Integrated Recipe Presentation higher.

Considering the task flow of cooks at the start of the recipe, no cooks performed mise-en-place when using recipes in the Integrated Recipe Presentation. This was as expected because (a) as described above, no cooks measured the ingredients when preparing recipes in the other Recipe Presentations and (b) there were no preparation instructions in the ingredient list in the Integrated Recipe Presentation. Cooks performed fewer ingredient look ups when using the recipe in the Integrated Recipe Presentation. This was as expected because the ingredient quantities were included in the text of the method instructions. However, cooks did perform a few ingredient look ups. This was not expected because the ingredient quantities were included in the text, however there was an error in preparation of the recipe texts and the quantity of one ingredient was omitted from the text. Cooks also referred to the ingredient list to check the specific type of an ingredient, for example olive oil or vegetable oil, or red or white onion.

When reading recipes in the Integrated Recipe Presentation, cooks read through the recipe in a more sequential manner and with fewer switches than for recipes in the other Recipe Presentations and they performed fewer tasks in parallel. Indeed, on three cooking sessions, cooks read through the method instructions in a linear read through pattern, they neither looked up ingredient list or looked ahead in the method instructions. In addition, fewer cooks performed tasks in parallel. These findings show that providing complete instructions (Eiriksdottir, 2001) in chronological and linear order (Ganier, 2004) enables cooks to progress through the recipe, reading and performing tasks in a more sequential manner and results in higher ratings. Further, these findings suggest that instruction design that integrates ingredient quantities and preparation instructions into the method instructions was a factor in the success of earlier interactive recipe systems such as *PersonalChef* (Mennicken et al., 2010).

6.4.4 Limitations of the study

6.4.4.1 Cook's experience

In previous studies, researchers have categorised cooks on a scale from novice to expert using a self-rating scale (Mennicken et al., 2010) or ascribed them a rating without describing how (Hamada et al., 2005). Frances Short (2003) argued that cooking expertise comprises a constellation of skills and knowledge that cannot be reduced to a single measure so in this study cooks were asked how often they cooked and used recipes, but no attempt was made to rate their level of expertise. However, it would be reasonable to expect that someone who cooks regularly and uses recipes regularly would have fewer problems than someone who does not but no correlation was found between a cooks' frequency of cooking or the frequency of using a recipe and the number of problems or non-compliance events they experienced while making the recipes. It might also be reasonable to expect that someone who cooks regularly would become faster. The time to complete results showed that some cooks were indeed faster than others, however this was not related to their declared cooking experience. The variation across participants was seen in multiple measures with no consistent underlying factor to distinguish them, this means that repeated measures is the most appropriate design for evaluating recipe support systems.

6.4.4.2 Selection of recipes

In studies of earlier recipe support systems, researchers have attempted to categorise recipes by difficulty. For example, Mennicken et al. (2010) described their salad recipe as simple, Hamada et al (2005) selected recipes that were "relatively difficult" (p372). Earlier researchers did not describe the criteria under which they made these categorisations and there is no objective measure of recipe difficulty so no attempt was made in this study to categorise them prior to use other than to demonstrate that they could be completed.

The cooks rated the recipes in the post-cooking questionnaire in terms of clarity and ease of use. They rated no difference in clarity between the recipes. The Pie recipe was rated easiest to use, with no difference seen between the Burgers and the Dip recipe. The Dip recipe had the lowest scores for ease of use, clarity, took the longest to complete and had the highest number of problems. This suggests the Dip Recipe was the most difficult recipe for the cooks although it is not clear why.

6.4.4.3 Sensitivity of measures

In this study, data was captured for qualitative analysis to provide a rich study of cooks' behaviours, supported by quantitative measures such as time to complete, count of problems and errors and cooks' ratings. Some quantitative measures, e.g. cooks' ratings, showed an effect of Recipe Presentation that generalised across the three recipes used in the study, while others, e.g. time to complete, did not. The reason they did not show effect lies in part in the sensitivity of the measure and in part in the difficulty of matching the materials, i.e. the recipes, in the repeated measures design.

Considering the differences between the Recipe Presentations the effect on time to complete would be limited to the time taken to switch between instructions and ingredient list and to parse shorter or longer recipe steps. The differences would reasonably be expected to be limited to a few minutes. However, although the three recipes selected for this study could be made in 30-35 minutes during trials, the mean time to complete one of the recipes in the study was nearly twice as high as for the other recipes and some cooks took nearly twice as long to prepare recipes as others. It was not possible, therefore, to detect any effect of Recipe Presentation on time to complete due to the variation among recipes and among cooks. Similarly, the counts of problems and errors showed no difference between the Recipe Presentations. This was in part because the count of problems and errors was low and in part because of the variation among recipes and cooks, i.e. some cooks had problems with one recipe and other cooks with another recipe.

This was the first study to take this battery of quantitative measures. The sensitivity of the measures was limited by the lack of adequate measures of recipe difficulty and of cooks' skills, meaning it was difficult to match recipes and participants. Future research should investigate ways to improve these measures.

6.4.4.4 Order effects

The experimental design was not fully counterbalanced; the Recipe Presentation was balanced with two Latin-squares but the Recipes were always presented in the same order. The Pie Recipe was the first to be made and was rated the easiest to use. The Dip Recipe was the last to be made. It took the longest, had the most problems and the lowest rating of clarity. Considering the problems experienced by the cooks, it is likely that confusing phrases such as "simmer rapidly" and difficulty in evaluating when the cooking was done were factors in the time taken and the low ratings of the Dip Recipe. However, as the cooking sessions took approximately 3 hours to complete it is not possible to rule out an order effect due to fatigue.

Alternative experimental designs could address issues of order effect and fatigue, for example running a fully counterbalanced experimental design or requiring participants to attend three sessions and prepare one recipe per session. The value of these alternative designs may not outweigh the costs; a fully counterbalanced design would require many more participants and a design with multiple sessions may run into retention problems. Further, as discussed above, as it was not possible to match the recipes for difficulty it is not clear if the poor timing and ratings for the Dip Recipe were due to order effects or due to the nature of the recipe and instructions therein.

6.4.4.5 Materials and equipment

There were some problems with the recipe software used in the study. The MacGourmet application was a quick and dirty solution to presenting the recipes on the iPad. However, the application was unstable for recipes with high numbers of steps, above 22 or 23 steps and as a result the application sometimes crashed when the cook swiped step 23 or 24. This situation happened in only one condition: the Dip Recipe in Integrated Recipe Presentation.

Despite the potential negative effect on the cooks' experience in this single condition only one cook mentioned it in the post-cooking questionnaire. Considering the scores in the post-cooking questionnaire, the cooks rated the recipe instructions as clearer and easier to use than in other conditions. This suggests that if there was a negative effect it was not large in comparison with the benefits of the Recipe Presentation. To minimise potential confounding factors due to unstable software, future research should use bespoke and robust application software.

There were some problems with recording the cooks' activities. Two cameras were placed in the kitchen to record activity but there were problems with both that impacted the data gathering from the study. The camera pointing at the iPad sometimes went out of focus because it depended on having a lot of contrast in the field of view. Some recipe instructions were sparse, leaving an almost white screen, and the camera lost focus. As a result, identifying the current recipe step on view was problematic sometimes. The other camera was placed above the iPad pointed at the work space. This was placed to capture when the cook looked at and read the recipe and their cooking activities. The angle of view was limited and sometimes the cooks looked at the recipe from the side on so their reading activity could not be captured. Some cooks also performed preparation and cooking activities away from the main work space so they were not captured on camera. In designing the kitchen layout for future studies, consideration should be made on the angle of kitchen visible to the cameras and the focus of those cameras.

6.4.5 Conclusion

The findings from this study show that the traditional format of recipes does not support cooks as they prepare recipes. Cooks found the long paragraph steps like a “wall of text” and difficult to read. As the cooks did not mise-en-place, so the separation of information between ingredient list and method instructions in the traditional format of recipes forced them to switch attention around the recipe thus increasing their cognitive work. When ingredient information was integrated into shorter method instruction steps cooks rated the recipes clearer to read and easier to use and showed a trend towards fewer problems with the recipe content. These findings support the findings and guidance from instruction design research and show that the design of the recipe instructions was an unexamined factor in the success of earlier interactive recipe systems.

This study also showed that cooks performed tasks in parallel and looked ahead in the recipe to help them interpret the current step. These behaviours have not previously been reported in the literature. Designs of instructions in earlier interactive recipe systems have focused on sequential reading and task performance so these behaviours have implications for the design. It would be useful to investigate designs that highlight the narrative of ingredients through recipes and enable cooks to work on several tasks at the same time.

Chapter 7 RECIPE2: Investigating the Effect of Pictures and Presenting an Overview of Recipe Instructions

7.1 Introduction

In this study 24 cooks prepared three recipes presented in three different formats: Control (traditional Recipe Presentation), Segmented instructions with pictures and Overview format. The study was designed to address the research questions: (1) how do pictures affect how cooks interact with recipe instructions? (2) how does an overview of the recipe procedure affect how cooks interact with recipe instructions?

7.1.1 Effect of adding pictures to recipe instruction steps

Recipe instructions often "describe how a mixture should look or feel at a certain stage" (Gibbs Ostmann and Baker, 2001, p23) so the cook can visually or sensually evaluate the state of their mixture. Consider, for example, this step from Delia Smith's recipe for shortcrust pastry[16]

> "Using a knife, cut the fat into the flour. Go on doing this until it looks fairly evenly blended…[rub in the fat] just long enough to make the mixture crumbly with just a few odd lumps here and there"

In this step the cook is told to cut the fat into the flour until it *looks fairly evenly blended* and then to rub in the fat until they see *just a few odd lumps here and there*. To make these visual evaluations the cook first has to make a mental transformation from the text to what they see in the bowl. These mental transformations draw on the cook's background and prior knowledge. They have to know what *evenly blended* looks like and how many odd lumps qualifies as *just a few*. If the cook lacks this knowledge or prior experience they may find the recipe difficult to interpret and perform as intended (Cotter, 1992).

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[16] http://www.deliaonline.com/how-to-cook/baking/how-to-make-shortcrust-pastry.html

One way of reducing the problem of lack of knowledge is to add pictures to instructions. With pictures there is “no need for mental transformation for a description” (Van der Meij & Gellevij, 2004, p. 8). They benefit users because they “can facilitate the elaboration of mental models and reduce ambiguity or imprecision” (Ganier, 2004, p. 22). Delia’s recipe for shortcrust pastry, quoted above, includes pictures at various stages of the recipe as did the designers of earlier interactive recipe systems such as *PersonalChef* (Mennicken et al., 2010) but they did not evaluate if or how the pictures improved cooks’ experience.

Previous research (Mayer, 2001) found that when people have little prior knowledge of the task they are about to do, adding pictures to textual instructions improves recall of instructions. Mayer explained the effect was as a result of the additional work, i.e. the cognitive effort required to select, integrate and organise information from two channels; the visual and the verbal. Mayer’s dual-channel model is concerned only with the two media, text and pictures. He did not investigate how the content of either affected the user. Schnotz and Bannert (2003), found that pictures only help users if the pictures are task-appropriate and the user has little prior knowledge. They showed that the content of pictures was important. Task appropriate pictures can compensate for poor textual instructions or poor reading skills because they provide an “additional route for mental model construction” (p62). Considering the case of poor textual instructions, pictures may help cooks with poorly written recipe instructions.

In the previous study, 66% of the cooks’ problems related to recipe content. Cooks had problems understanding ambiguous instructions and incomplete instructions. For example cooks found the instruction “simmer rapidly” ambiguous and wanted additional information to clarify how rough or finely they should “chop the tomatoes”. Cooks also wanted more “information on consistency” to help them evaluate the mixture during the preparation. These problems suggest that the recipe instructions were of poor quality. The findings of Schnotz and Bannert (2003) suggest that adding pictures may compensate for the poor instructions and reduce the number of problems experienced by the cooks.

Pictures may also reduce the number of errors performed by cooks. In the previous study, more than half of the errors performed by cooks related to tasks such as slicing when cooks interpreted the instruction to mean chop. For example cook 24 said “it doesn’t say chopped but in fact it means chopped. You’ll say in a second it does actually mean sliced and I’ll have problems…”. If the instruction was associated with a picture the cook could clarify their interpretation of the instruction and thus reduce the number of errors performed.

Pictures, and videos, have been incorporated into recent interactive recipe systems but they have been one design factor of many in the physical and interactive designs of systems and their value has not been evaluated in isolation from other design factors. For example, *PersonalChef* (Mennicken et al., 2010) incorporated pictures and videos as one factor in their system design that also included a touch screen embedded in a work surface and a display behind the stove. Considering the design of interactive recipes on a small screen mobile device where the focus is on the interactive design rather than on a large scale installation in the kitchen it would be useful to investigate if pictures assist cooks with understanding recipe instructions.

7.1.2 Effect of an overview of recipe instructions

In the previous study I found that cooks did not read recipe instructions in sequence nor did they perform the tasks in sequence. They looked ahead in the recipe to find tasks to perform in parallel and to help them interpret the current task. For example, Cook 7 in the previous study wanted to know how fine the biscuits should be crumbled in the Pie recipe. To do this he looked through the recipe to find the narrative of the ingredient through the instructions. He said “what are we aiming at, sort of bread crumbs or ? … I'll just have a look at what it wants me to do with them”. Further, the cooks did not perform a mise-en-place, rather they switched attention between method instructions and the ingredient list and created an activity plan on the fly as they were preparing the recipe. These findings show that a sequential delivery of recipe instructions does not support the way that cooks work.

One of the reasons is that step-by-step instructions make it difficult for them to link the actions in the steps to the goals. Steehouder et al. (2000) argued that instruction users create representations of instructions on three levels; (1) syntactic to translate the words to an action, (2) semantic to understand the goal and (3) situational to understand the meaning in the real world. The cook quoted above, was about to perform the action “bash the biscuits” (syntactic) and wondered if the goal was to reach a state like breadcrumbs (semantic) and to do this he wanted to understand how they would be used in the wider context of the recipe (situational).

Organising instructions into goals and sub-goals with appropriate headings helps users locate information in instructions (Ganier, 2004). However, the use of headings to mark goals and sub-goals is not discussed in the design of earlier recipe support systems.

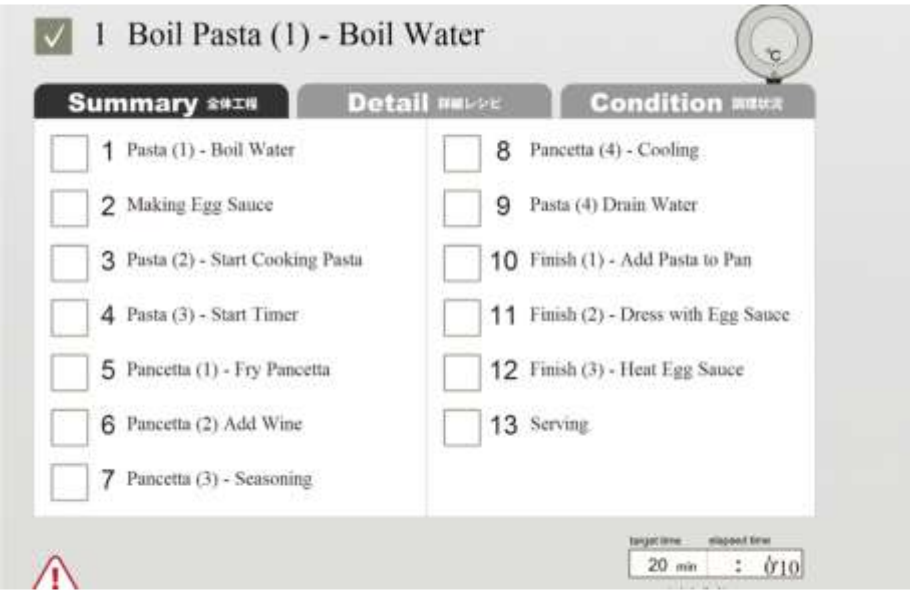

Figure 49: Panavi summary page showing sub-goals

Figure 49 shows the summary page of the *Panavi* (Uriu et al., 2012) recipe support system. Of the earlier interactive recipe systems, this was the only one that showed steps in the recipe organised into sub-goals. The sub-goals are titled “Pasta” (steps 1, 3, 4, 9), “Pancetta” (step 5, 6, 7, 8) and “Finish” (steps 10, 11, 12) with steps 2 and 13 standing alone. The selection of titles for sub-goals and the organisation of instructions under them was not discussed in the paper and the design feature was not evaluated so it is not clear if or how they helped the cook understand and prepare the recipe.

Figure 50 shows the user interface of *HappyCooking* (Hamada et al., 2005) that provided cooks a flow chart of recipe instructions designed to help “users confirm the cooking process” (Siio et al., 2007, p952). This approach suggests an alternative visual design to providing titles of sub-goals within a sequence of textual instructions. It might provide the support needed by cooks who seek out the narrative of an ingredient or look for tasks to perform in parallel with other tasks. For example, cook 12 in the previous study said “I was just seeing if there is anything I can be doing while the butter is melting. It’s nice to be efficient”. However, Hamada et al., did not evaluate their flowchart presentation so it is not clear if this representation of the recipe instructions benefited the cooks.

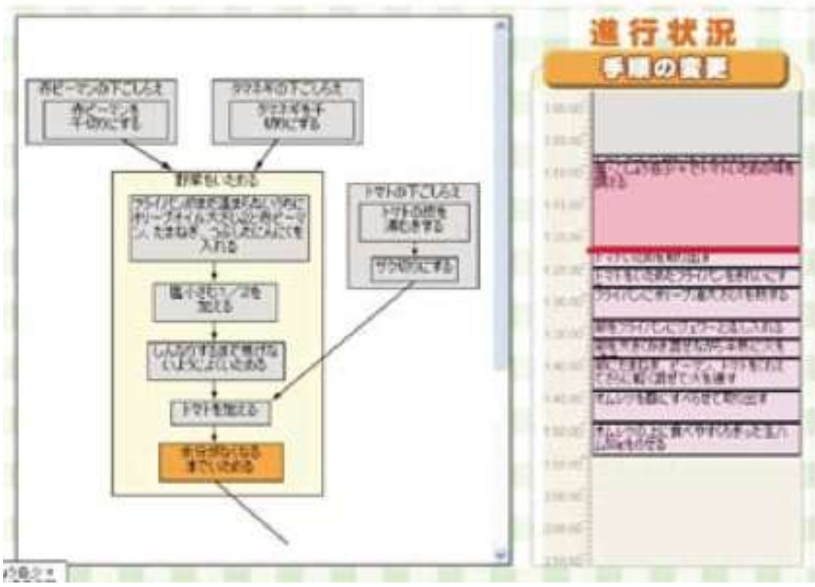

Figure 50: Happy Cooking instructions

Stepping back from interactive recipe systems and the traditional textual recipe format, other representations of recipes have been proposed by engineers and graphic designers. Two are introduced below. They suggest potential novel designs that could be incorporated in interactive recipe systems.

Tuna noodle casserole (serves four)

<table>
<tr><td colspan="9">Preheat oven to 350°F (175°C)</td></tr>
<tr><td>4 Tbs. (60 g) butter</td><td>melt</td><td rowspan="2">stir</td><td rowspan="3">thicken</td><td rowspan="9">mix</td><td rowspan="11">season</td><td rowspan="13">mix</td><td rowspan="15">top</td><td rowspan="15">Bake 350°F (175°C) 30 min.</td></tr>
<tr><td>1/4 cup (40 g) all purpose flour</td><td></td></tr>
<tr><td>2-1/2 cup (590 mL) whole milk</td><td colspan="2"></td></tr>
<tr><td>1 Tbs. (15 g) butter</td><td>melt</td><td rowspan="4">saute</td><td rowspan="6">stir</td></tr>
<tr><td>4 oz. (115 g) sliced mushrooms</td><td rowspan="3"></td></tr>
<tr><td>1/2 cup (50 g) chopped scallions</td></tr>
<tr><td>1/4 cup (25 g) chopped celery</td></tr>
<tr><td>1 tsp. (1.2 g) dried rosemary</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>1 tsp. (1.4 g) dried thyme</td></tr>
<tr><td>salt</td><td colspan="4" rowspan="2"></td></tr>
<tr><td>ground black pepper</td></tr>
<tr><td>8 oz.(230 g) egg noodles</td><td>cook</td><td colspan="4" rowspan="2"></td></tr>
<tr><td>12 oz. (340 g) light tuna</td><td>drain</td></tr>
<tr><td>4 Tbs. (60 g) butter</td><td>melt</td><td rowspan="2">cook</td><td colspan="4" rowspan="2"></td></tr>
<tr><td>1 cup (120 g) bread crumbs</td><td></td></tr>
</table>

Copyright Michael Chu 2004

Figure 51: Block-style recipe format from Cooking for Engineers

Figure 51 shows a recipe for Tuna noodle casserole in a form developed by Michael Chu on the website *Cooking for Engineers*[17] . The ingredient list on the left is presented in the familiar list style but the instructions are presented in blocks to the right. The recipe proceeds from the left to the right, each block builds on those to the left. Where the instruction block touches the left column this indicates the ingredients to be added at each stage of the recipe.

[17] http://www.cookingforengineers.com/

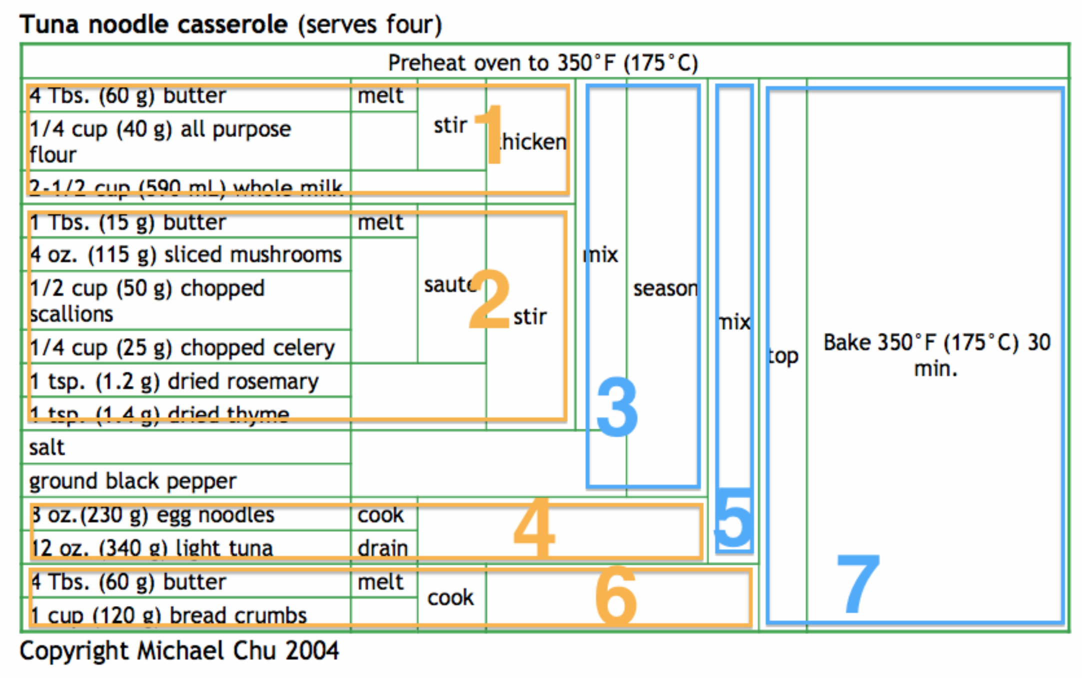

Figure 52: Annotated block-style recipe format from Cooking from Engineers

Figure 52 shows how the blocks of the Cooking for Engineers recipe indicates different stages of the recipe and they are combined. The orange blocks indicate different parts of the recipe that work on sub-sets of ingredients. The blue blocks indicate where the parts of the recipe are combined. Written as a textual recipe this could be represented as:

1. Make the sauce
2. Fry the vegetables for the sauce
3. Combine the outcomes of 1 and 2
4. Prepare noodles and tuna
5. Combine outcomes of 3 and 4
6. Prepare topping
7. Combine outcomes of 5 and 6, and bake

Chu's recipe design shows the reader how the different parts of the recipe fit together and indicate where there is no dependency (for example between parts 1 and 2) and the parts could be performed in any order or in parallel. However, although these features are available from the recipe design they are not readily discernable and the flowchart form illustrated below makes these parts of a recipe and how they fit together more visually clear.

Figure 53: Flowchart recipe from Chavelli Tsui

Figure 53 shows a recipe for an omelette in a form developed by Chavelli Tsui. It was submitted to a competition to redesign the recipe on the website *good.is*[18] in 2001. There are two key aspects of this design that may help cooks. Firstly it shows the multiple parts of a recipe and the tasks that make up each part and secondly it shows how the ingredients are linked to the tasks.

Considering the multiple parts and tasks in the recipe, in personal communications (April 2013) Tsui explained the design was created to make visual the multitasking requirements or opportunities of recipes because "if you don't read ahead in advance and constantly flick up and down in steps to see what is coming up, you often waste time or simply don't realise how many

[18] http://www.good.is/posts/submission-redesign-the-recipe

simultaneous steps are going on.” In other words she described the activity seen in the previous study where cooks looked ahead to find tasks to perform in parallel and how her design might support it better than textual recipes. Beyond that, her flow chart format also presents a clear representation of how each component of the recipe is prepared and then combined to produce the final dish. In common with, but arguably in more striking form than the block-style design from Chu, Tsui’s design provides an overview of the recipe process where both the parallel streams of tasks and the connections are made visible.

Considering the ingredients linked to tasks, Tsui’s flowchart design also provides a connection between sub-sets of ingredients and the steps in which they are used that is absent from the traditional format of recipes that lists ingredients in a single list. The separate ingredient list helps cooks check their pantry for ingredients while they browse for a recipe they can prepare but it does not help cooks during the process of cooking the recipe. Contrary to the expectations of Gibbs Ostmann and Baker (2001), cooks do not assemble and prepare their ingredients before starting on the method instructions. They prepare ingredients when there is time in between performing tasks in the method instructions and they measure ingredients when they are introduced into a method instruction step.

In the previous study, recipe instructions that integrated the ingredient quantities into the text of the recipe step were rated clearer to read and easier to use than those that required cooks to switch attention from the recipe step to search the ingredient list for needed information. It is likely that clustering sub-lists of an ingredient list with recipe steps would reduce this search space and benefit the cook.

In this study I investigate the effect of presenting a recipe with an overview that shows the overall structure of the recipe tasks, the goals and sub-goals and links the ingredients with the steps they are used in. The visualisation was inspired by these graphic design representations. It incorporates the flowchart design of Figure 53 with a linear ingredient list divided and linked to the steps they are used in as seen in Figure 51. The full text of recipe steps and pictures were linked as pop-ups from the recipe overview. This enabled the cook to move between a high level overview of the recipe to a low level detailed view of individual steps.

7.1.3 Methodology improvements

The design of this study was based on that of the previous study with several improvements. Further considerations of the cooks' experience levels were taken, including a self-rating scale, frequency of cooking and type of cooking engaged in. In earlier studies of recipe support systems, cooks' experience levels were taken from single measures such as a self-rating scale (1-5) (Mennicken et al., 2010) and categorisation (Hamada et al., 2005) but it was not clear how the cooks' experience affected their success or experience with the systems.

In the previous study no attempt was made to categorise the recipes used in terms of difficulty. In earlier recipe support systems, part of the design motivation has been to increase the confidence of cooks using novel and difficult recipes (Mennicken et al., 2010) and to improve the efficiency of making "relatively difficult" recipes (Hamada et al., 2005). The authors did not, however, describe the method by which they categorised or rated the recipe difficulties.

The equipment and materials were improved in this study. The recipe system was delivered from a webserver that enabled more precise measures of the time recipe steps were on screen. More cameras were deployed in the kitchen to reduce blind spots in the kitchen and improve the freedom of the cook to work where they were comfortable.

A limitation of design was that precise measures of the cooks' reading activities could not be taken without access to eye-tracking equipment. As a consequence it was not possible to gather detailed valid data on the time cooks spent reading individual recipe steps and pictures. A further limitation of the design due to lacking a retrospective protocol was that it was not possible to categorise errors made by cooks into slips, lapses and mistakes (Reason, 1990).

7.1.4 Research questions

Findings from instruction design research shows that adding pictures to textual instructions helps users because it reduces the mental transformation they have to do. Recipes often contain visual evaluation phrases that rely upon cooks' prior knowledge and experience to enable them to successfully perform the mental transformation and evaluate the state of their ingredients or mixture. Earlier interactive recipe systems used pictures and videos in their designs in order to help cooks understand their instructions and perform them more accurately, however none performed evaluations to investigate if these pictures and multimedia were a factor in the success of their systems.

Findings from the previous study showed that cooks do not read recipes sequentially or perform the tasks sequentially. They need support to understand the narrative of ingredients and to find tasks to perform in parallel. Flow chart designs, such as that by Tsui (as seen in Figure 53 above), provide a novel design for recipes that could support these activities. They share features with the design of recipe graphs being developed by researchers in semantic analysis. This shows potential for novel design of interactive recipe systems that could help cooks understand the overall structure of a recipe, and search for ingredient information as they need it and for tasks to perform in parallel.

This study investigates two research questions:

- How do pictures affect how cooks interact with recipe instructions?
- How does an overview of recipe instructions affect how cooks interact with recipe instructions?

7.2 Method

7.2.1 Design

The study had a repeated measures design with two independent variables: Recipe and Recipe Presentation. Recipe had three levels: Microwave coffee and walnut cake (Cake), Salad with gremolata (Salad) and Linguini with mince (Linguini). Recipe Presentation had three levels: Control, Segmented-with-pictures (Segmented) and Overview instructions (Overview). The recipe formats are outlined below in section 7.2.4.

Data was captured for both quantitative and qualitative analysis for a rich study of the patterns of cooks' behaviours supported by quantitative measures of time taken to read and complete the recipe and cooks' ratings of the recipes.

The order of Recipe Presentation was counterbalanced with two cyclic-design Latin squares. Table 47 shows how participants were allocated to one of six differently ordered groups of Recipe Presentation. For the purposes of analysis, participants 1-12 were located in the first Latin square and participants 13-24 were located in the second Latin square.

Table 47: Order of conditions presented to participants

Recipe/ Participant ID Range	Cake	Salad	Linguini
1-4	Control	Segmented	Overview
5-8	Segmented	Overview	Control
9-12	Overview	Control	Segmented
13-16	Overview	Segmented	Control
17-20	Segmented	Control	Overview
21-24	Control	Overview	Segmented

7.2.2 Participants

Overall there were 24 participants, 8 in each condition. There were 12 women (50%). The participants ranged in age from 18 to 25 years (M=21.0, SD=1.7). All participants were students of University of York, 8 were international students. Ten participants were reading for social science degrees, 9 for science and engineering degrees and 5 for arts and humanities degrees.

7.2.2.1 Participant cooking skills and experience

Participants were asked about their cooking experience and how they would assess their own cooking skills in a pre-study questionnaire [see Appendix 5]. They were asked when they learned to cook, how frequently they cooked and what type of ingredients they used e.g. raw, prepared or ready meals. They were asked how often they used recipes, where they sourced recipes and how they used them.

Considering the cooking experience of the participants, 13 (9 women, 4 men) learned to cook from their parents, seven (2 women, 5 men) learned independently as adults, three from school and one from cooking courses. Participants cooked 5.4 days per week (SD=2.0), thirteen (54%) cooking for themselves only. A further 10 (42%) cooked for themselves and one other person.

Participants were asked to rate their cooking skills on a scale of 1-5 described against the following statements:

1. little or none
2. know enough to get by, but not how to prepare a great variety of food
3. can prepare a simple meal without much problem
4. can prepare a good range of dishes, occasionally try new techniques
5. can prepare many dishes and regularly try new techniques and recipes

The mean self-rating was 3.54 (SD=1.06).

The participant's self-rating score was correlated with their cooking frequency over a week, $r(22)=.518$, $p<0.01$ (two-tailed). Considering the type of ingredients the cooks used, 19 (79%) rarely used ready meals and 17 (71%) frequently cooked from raw ingredients. Ingredient source was scored on a scale of 1-3 (1=ready meals, 2=prepared ingredients, 3= raw ingredients). The scores were analysed for correlation against self rating score. The self rating score was not correlated with use of raw ingredients, $r(22)=.356$ ($p=.088$, two-tailed), but was negatively correlated with use of ready meals, $r(22)=-.551$, $p<0.01$ (two-tailed). Cooks with higher self rating cooked more often and used ready meals less often but they did not use raw ingredients more often. This indicates the difficulty of grading cooking skills on a small number of dimensions (Short, 2003).

Participants used recipes 2.88 times in the previous month (SD=2.27). Considering the most recent recipe used, sixteen participants (67%) used recipes sourced from the internet, four (17%) from cookbooks and the remainder used recipes from family and friends or from ingredient packages. Of the recipes sourced from the internet, ten participants (65%) used their laptop or smartphone to read the recipe, 6 (37%) printed out the recipe and worked from the paper copy. This shows that most cooks were familiar with using technology in the kitchen.

The findings of the questionnaire show that cooks do not, as a rule, follow recipes to the letter, although the reasons are not clear. Fourteen participants (88%) made at least one amendment to the recipe: nine (38%) substituted at least one ingredient and altered the method of the recipe, seven (29%) substituted at least one ingredient of the recipe and only six participants (25%) followed the recipe to the letter. Of those that used recipes from the internet, only two followed the recipe to the letter. By contrast only two participants (50%) amended recipes sourced from a cookbook. Cooks of all self-rated skill levels deviated from the recipe instructions. No correlation was found between self-rating score and a dichotomous categorisation of following the recipe or deviate from the recipe, $r_{pb}=.023$, $p=.915$.

7.2.3 Equipment and materials

7.2.3.1 Kitchen

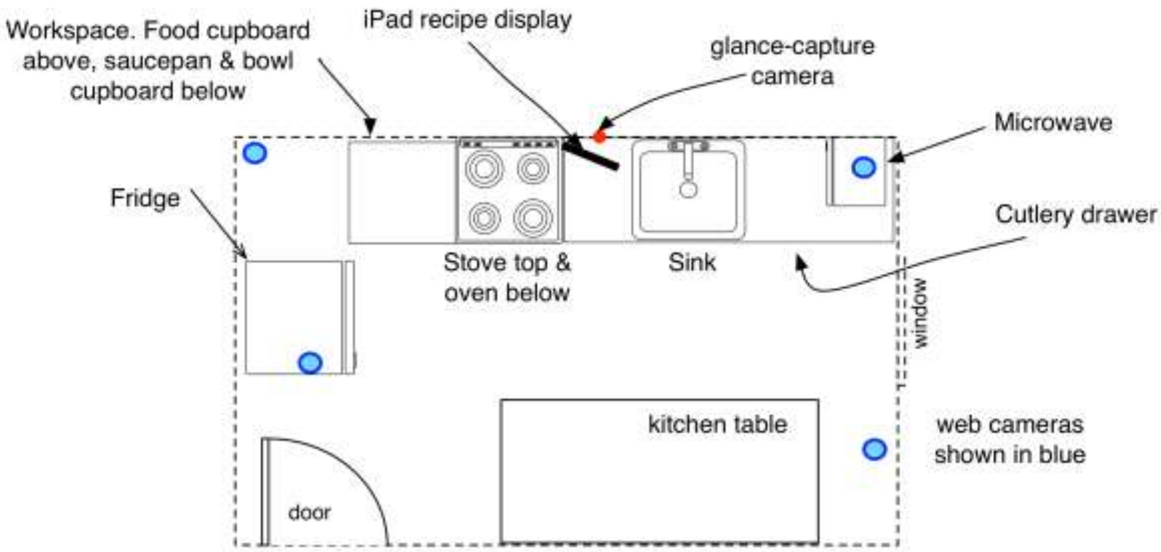

Figure 54: Kitchen layout showing cameras

The study took part in the same kitchen as the previous study with some changes made to the kitchen layout. Figure 54 shows the fridge was moved to the left hand wall. All the food ingredients were stored in either the fridge or the cupboard over the first work space area. Large utensils were presented at the back of this work surface, standing up in pots. Cutlery was presented in the drawer to the right of the sink, as in the previous study. The large utensils, bowls and saucepans were stored in the cupboard underneath the first work space. The wide-angle cameras are shown as blue dots. The glance-capture camera is shown as red dot.

7.2.3.2 Recipe presentation: iPad

The recipes were presented to the cook on an iPad. This was in a fixed location as shown in Figure 54.

7.2.3.3 Recording equipment

Four wireless wide-angle cameras were used to capture the cooks' activities anywhere in the kitchen and one camera to capture the cook looking at the iPad. Figure 54 shows the location of the cameras in the kitchen, one in each of three corners and one on the top of the fridge. The feed from the cameras was captured with proprietary software in a 4 by 4 grid and this video feed was captured and recorded using Morae on a PC in an adjacent room. A microphone was used to record the cooks' speech.

7.2.4 Recipes

7.2.4.1 Recipe levels

Three recipes were used in the study: Microwave coffee and walnut cake (Cake) (BBC Good Food website[19]), Tomato, bean and potato salad with gremolata (Salad) (Harriott, 2007, p. 160) and Linguini with mince (Linguini) (Contaldo, 2011, p. 64). The quantity of ingredients was reduced by 50% in the Salad and Linguini recipes, no other adaptions were made. There were three Recipe Presentations: Control, Segmented-with-pictures (Segmented) and Overview. The different presentations are illustrated below. They were selected to provide a range of cooking techniques and be completed within 30 minutes.

7.2.4.2 Recipe presentation

The recipes were delivered as a series of webpages written in HTML5. They were displayed to the cooks using full screen mode of Dolphin (http://dolphin-browser.com) a web browser on the iPad.

The first screen the cook saw was the "Start here" page shown in Figure 55.

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[19] http://www.bbcgoodfood.com/recipes/1120665/microwave-coffee-and-walnut-cake

The “START HERE” button triggered the Title page of the recipe to be made and was the start point from which to measure time to complete. From the Title page, shown in Figure 56, the cook could choose to view the Ingredients list or Step 1 of the recipe (for recipes in the Control or Segmented presentations) or the Overview page (for recipes in the Overview presentation). The screenflow for each of the presentations is shown below followed by screenshots of the recipes in each presentation.

The format for each Recipe in each Recipe Presentation and the associated pictures are included in Appendix 6.

Figure 55: Recipe on iPad - Start here page

Recipe pages: Title page

Figure 56: Recipe on iPad - Title page for Salad recipe

Screenflow for Recipes in the Control and Segmented-with-pictures Recipe Presentations

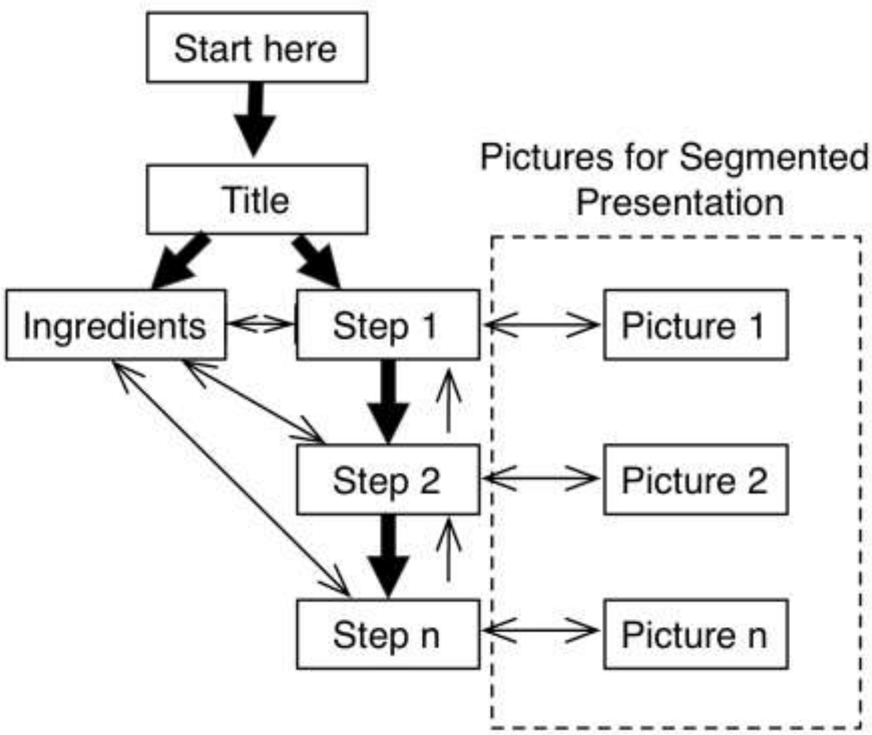

Figure 57: Recipe on iPad - Screenflow for recipes in Control and Segmented Recipe Presentations

Figure 57 shows the screenflow for recipes in the Control and Segmented Recipe presentations. The pictures apply only for recipes in the Segmented Recipe presentation.

At the Title page the cook could choose to view the Ingredients list or Step 1. From Step 1 the cook could move to Step 2 and onwards through the recipe one step at a time. From any step the cook could move to the previous step or to the Ingredients list. For recipes in the Segmented Recipe presentation, cooks could move to the picture associated with the current step and back to the step.

Recipe pages: Ingredients list

Figure 58: Recipe on iPad - Ingredients list for Salad recipe

Figure 58 shows the Ingredient list page for the Salad recipe in Control and Segmented-with-pictures Recipe Presentation. From this page the cook could return to the Title page or to the current recipe step.

Recipe pages: Steps in Control Recipe Presentation

Figure 59, Figure 60 and Figure 61 show steps 1 through 3 of the salad recipe in the Control Recipe Presentation. The wording of the steps was as in the original source (Harriot, 2007, p160). Step 3 was a long step so the later part of the step was below the fold. On any step the cook can move one step forward or back and to the ingredient list.

Recipe pages: Steps in Segmented Recipe Presentation

Figure 62, Figure 63 and Figure 64 show steps 1 through 3 of the salad recipe in the Segmented Recipe Presentation that are the equivalent of Step 1 in the Control Recipe Presentation. The steps illustrate how the original text was broken up into shorter steps with a single task per step. The recipe steps were broken up using the same procedure as used in the previous study; each step in the Segmented Recipe Presentation represented one task to be performed.

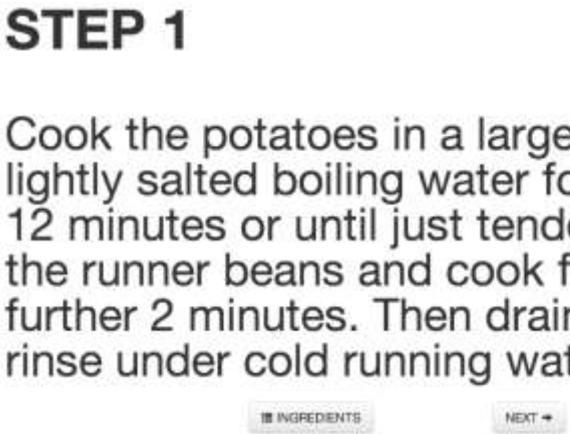

Figure 59: Recipe on iPad - Step 1 of Salad recipe in Control Recipe Presentation

Figure 60: Recipe on iPad - Step 2 of Salad recipe in Control Recipe Presentation

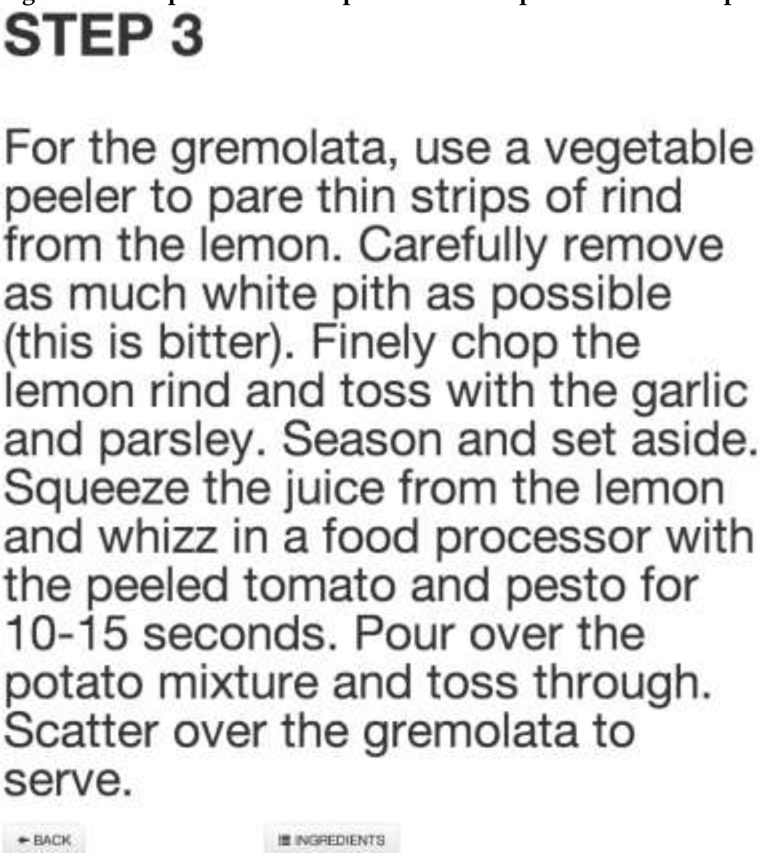

Figure 61: Recipe on iPad - Step 3 of Salad recipe in Control Recipe Presentation

Figure 62: Recipe on iPad - Step 1 of Salad recipe in Segmented Recipe Presentation

Figure 63: Recipe on iPad - Step 2 of Salad recipe in Segmented Recipe Presentation

Figure 64: Recipe on iPad - Step 3 of Salad recipe in Segmented Recipe Presentation

Recipe pages: Pictures

For recipes in the Segmented-with-pictures Recipe presentation, where the goal of the step involved a visual change of state the step was associated with a picture of the goal state of the step. The pictures were taken in the Homelab kitchen using the utensils later available to the participant cooks. Figure 65 shows step 4 of the Salad recipe in Segmented Recipe Presentation with a button to show the associated picture. Figure 66 shows the picture page associated with step 4 of the salad recipe. The only exit point is back to the recipe step.

Figure 65: Recipe on iPad – Step 4 of Salad recipe in Segmented Recipe Presentation

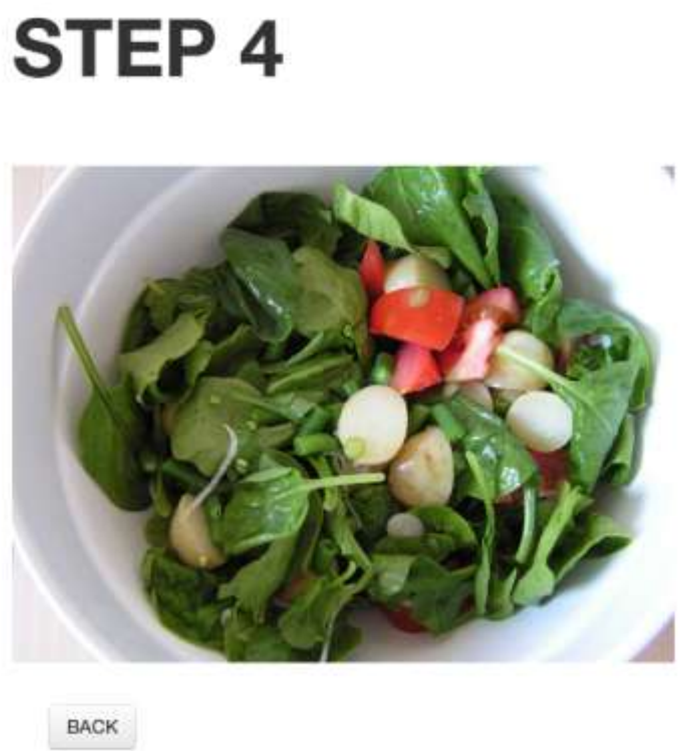

Figure 66: Recipe on iPad – Step 4 picture of Salad recipe in Segmented Recipe Presentation

Screenflow for Overview Recipe Presentation

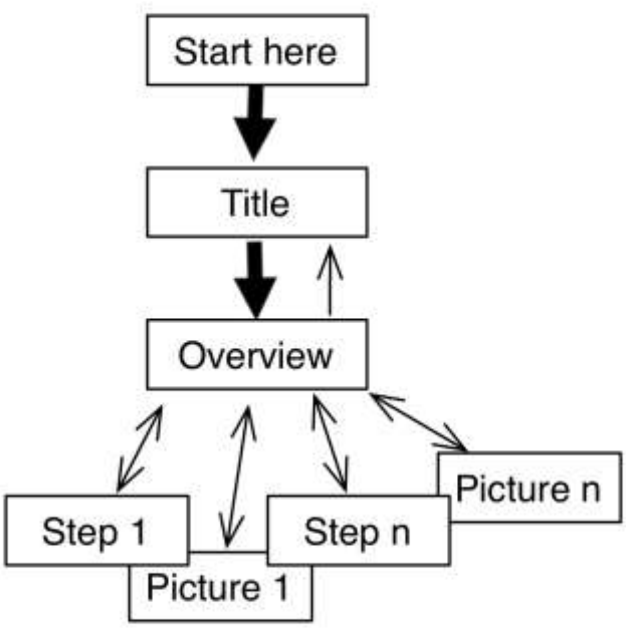

Figure 67: Recipe on iPad - Screenflow for recipes in Overview Recipe Presentation

Figure 67 shows the screenflow for recipes in the Overview Recipe presentation. At the Title page the cook moves to the Overview page. From the Overview page the cook could choose to view any step and any picture at any time and return to the Overview page.

Figure 68 shows the Overview page for the Salad recipe. The ingredients are shown on the left of the page and brief instructions shown in a flowchart form to the right. The recipe instructions are organised into sub-goals, each with a title. Recipe instructions are associated with ingredients with a light grey box. Tapping on the blue briefly worded instructions brings up the detailed recipe instruction that is shown in Figure 69. Tapping on the button to the right of the brief instruction brings up the associated picture that is shown in Figure 70.

Recipe pages: Overview

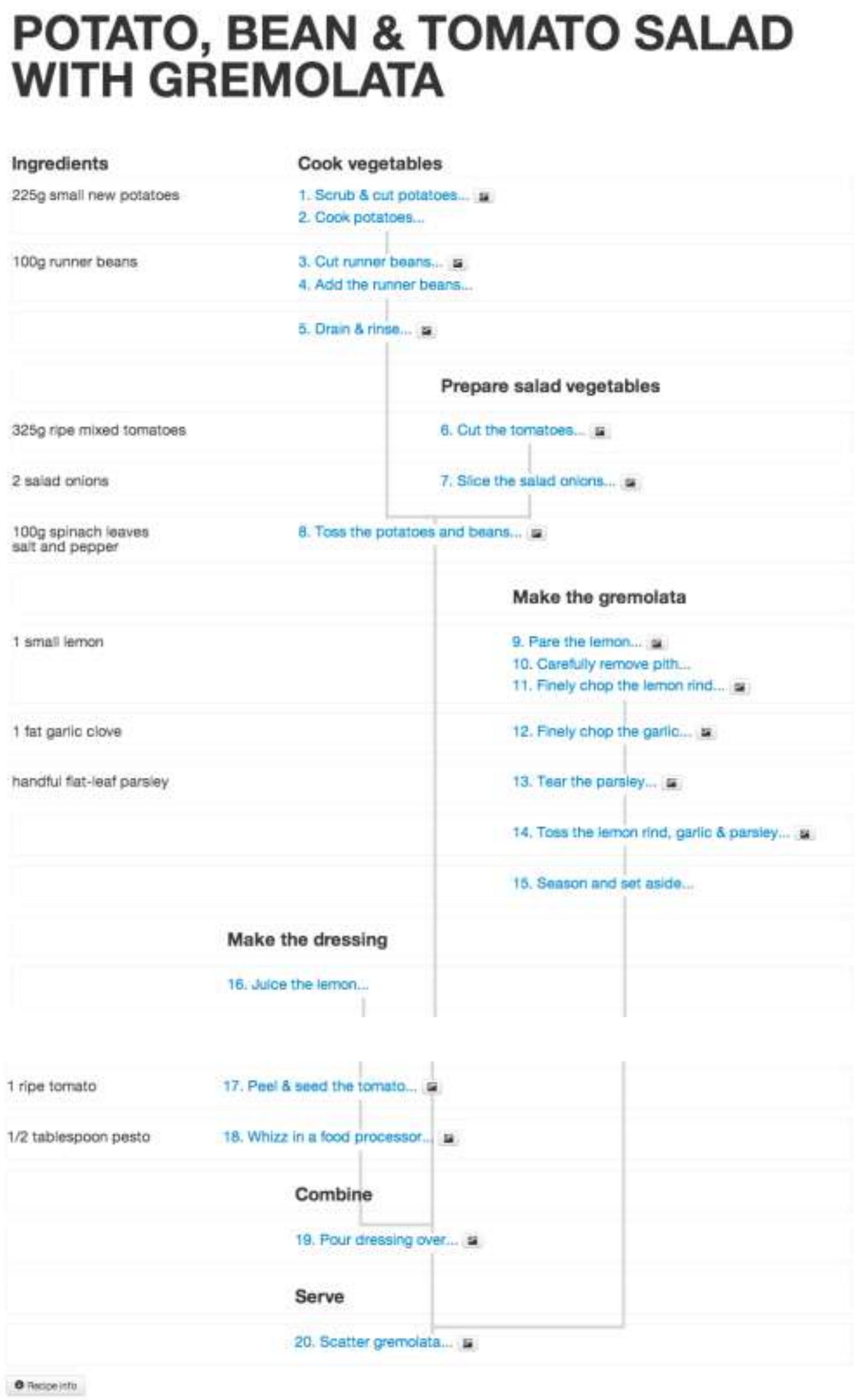

Figure 68: Recipe on iPad - Salad recipe Overview page

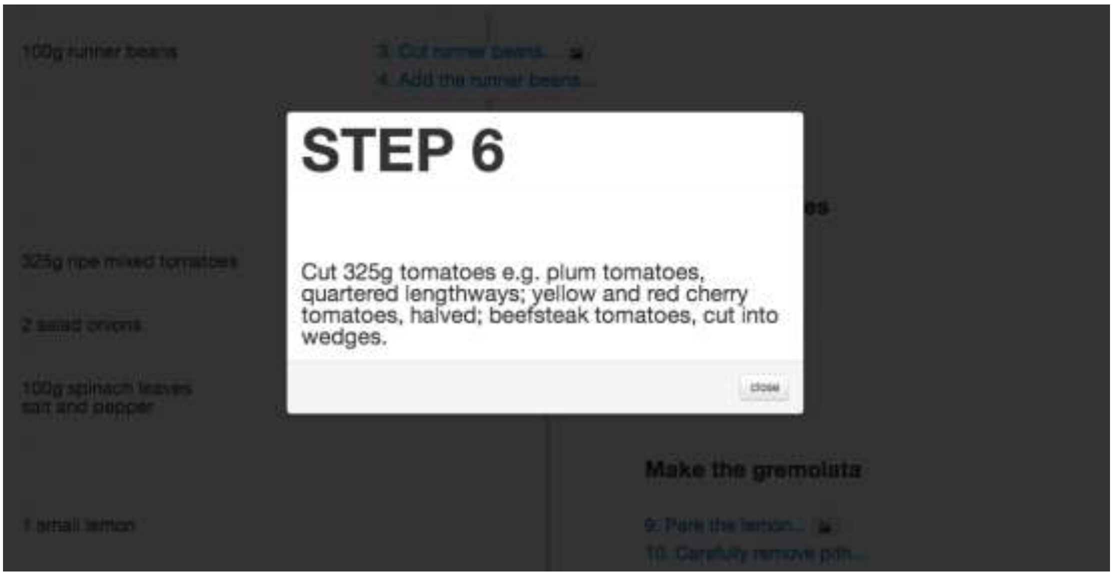

Figure 69: Recipe on iPad – Step 6 detail pop-up of Salad recipe in Overview Recipe Presentation

Figure 69 shows the detailed recipe instruction as a pop-up over the Overview.

The text contains the ingredient quantity.

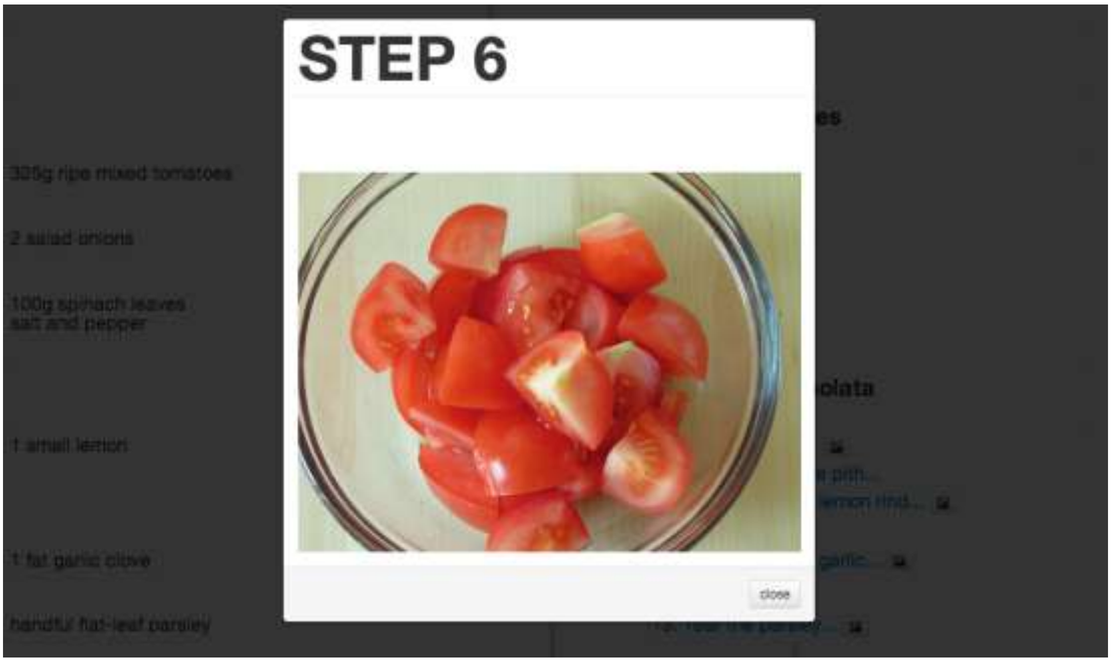

Figure 70: Recipe on iPad – Step 6 picture pop-up of Salad recipe in Overview Recipe Presentation

Figure 70 shows the picture pop-up over the Overview page.

7.2.4.3 Questionnaires

The questionnaires can be found in Appendix 5.

Participants' cooking experience questionnaire

Prior to attending the session the participants completed a questionnaire about their cooking skills and experience. The questionnaire was delivered using Survey Monkey.

Pre-cooking questionnaires

Before each cooking session, cooks were shown the title of the recipe, the recipe description and the list of ingredients and asked to complete a short pre-cooking questionnaire. The questionnaire was delivered using Google Docs. Three questionnaires (one for each recipe) were created.

Post-cooking questionnaires

After each cooking session, participants were asked to complete a questionnaire about their experience. Two versions of the questionnaire were created; one for recipes without pictures (recipes in Control Recipe Presentation), one for recipes with pictures (recipes in Segmented and Overview Recipe Presentation). The latter matched the former with the addition of two questions relating to pictures.

7.2.5 Procedure

Participants attended one 3-hour session during which they were briefed, cooked three recipes with a break between each and were debriefed.

7.2.5.1 Briefing session

The briefing session followed the same protocol as the previous study, except that the participants were not shown the recipes they would be preparing.

7.2.5.2 Cooking sessions

At the start of each cooking session the cook was asked to complete the pre-cooking questionnaire. A short training session followed where the cook was shown how to use the controls of the sample recipe in the appropriate format and allowed to explore the recipe. When the cook was happy with the recipe controls, the Morae recording session was started and the cook told to start the recipe.

During the cooking session the observer stayed in the kitchen to observe, answer any questions and remind the cook to use the think aloud protocol.

When the recipe was complete the observer triggered the post-cooking questionnaire and the cook was asked to complete it at the kitchen table and then take a break.

7.2.5.3 De-briefing

At the end of all three cooking sessions the cooks were given a verbal debrief and the food they had prepared packed up to take away. During the debrief they were told the purpose of the study was to investigate the effect of different presentation of recipe instructions on the time taken and the errors made.

7.2.6 Data preparation

Data was gathered from five sources: the Participants' cooking experience questionnaire, the pre and post-cooking questionnaires, the Morae video recording of each cooking session and the web-logs from the recipe web pages.

7.2.6.1 Data preparation of participants' cooking experience questionnaires

The questionnaire was delivered using SurveyMonkey[20]. Responses were

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[20] http://www.surveymonkey.com/

exported in spreadsheet format and summarised for further analysis.

7.2.6.2 Data preparation of Pre- and Post-cooking questionnaires

The questionnaires were created using Google Docs Forms and the data captured in Google Docs Spreadsheets. The responses from all pre-cooking questionnaires were collated and exported in spreadsheet form for further analysis. The responses from both post-cooking questionnaires were collated and exported in spreadsheet format for further analysis.

7.2.6.3 Data preparation from the web logs

The web logs were downloaded from the server and each cooking session extracted for further analysis. Each line in a web log describes a request to the server for a web page. It contains the timestamp of the request, the page requested, the source of the request (IP address and operating system). Each cooking session was identified as starting with a request for "start here" page and ending with request for the post-cooking questionnaire. Elapsed time through the cooking session was calculated from the request for the "start page".

Time on screen for different parts of the recipe

The Total time to complete the recipe was calculated as the time elapsed between the request for "start here" page and the post-cooking questionnaire request. Each recipe step was visible on screen on one or more occasions bounded by the time of the request for that step and the time of the next request. The duration of each of these occasions was summed to calculate the total visible time on screen for each recipe step. The timeline of visible steps was aligned with the timeline of reading events to calculate the total time reading each recipe step.

Progression maps

For each cooking session, the timeline of visible recipe steps was visualised as a progression map.

7.2.6.4 Data preparation from video recordings

The video recording from each cooking session was imported into Morae manager. Each recording was analysed. Activities were coded and the think aloud utterances transcribed. Activities coded included the start of the cooking session (when the cook was seen to tap the “start here” button), the start and end of each reading event, cooking task activities. The codes were exported from Morae, creating a time stamped transcript of events and utterances for further analysis. An adjusted timestamp was generated, where zero was the time when the cook tapped the “start here” button.

Reading events

A reading event was defined as the time from when the cook looked at the iPad and they looked away as recorded on the camera placed above the iPad. The duration of each reading event was then summed to provide the total reading time for the cooking session. The measure for start and end of reading events was based on video of when the cook looked at the screen. The measure did not have high precision so it was not possible to calculate the time spent reading individual steps.

Transcript analysis for problems, errors and behaviours with implications for design

The transcript of activities and utterances was analysed to identify problems, errors and behaviours with implications for design. Problems were identified where cooks raised an issue or asked a question of the observer that they could not answer from the recipe. Errors were identified when cooks omitted a task described in the recipe, added a task not described in the recipe or performed a task differently from described in the recipe.

7.3 Results

The results section is organised in 5 sections; (1) time taken to read and complete the recipe, (2) post-cooking questionnaire, (3) problems, (4) errors and (5) behaviours with implications for design.

7.3.1 Time to complete, view and read the recipes

7.3.1.1 Time-to-complete the recipes

In order to investigate the effect of Recipe Presentation on efficiency, the time taken to complete the recipes was compared. The time to complete each recipe was taken from the time the cook tapped the start-here button to the time the observer opened the post-cooking questionnaire.

Table 48: Mean time-to-complete recipes (SD) by Recipe and Recipe Presentation, in seconds

Recipe	Control	Segmented	Overview	Mean
Cake	2033 (454)	2135 (333)	2577 (580)	**2248 (507)**
Salad	2938 (657)	3160 (392)	2914 (640)	**3004 (562)**
Linguini	1999 (413)	1774 (412)	1644 (218)	**1805 (375)**
Mean	**2323 (666)**	**2356 (701)**	**2378 (737)**	**2353 (692)**

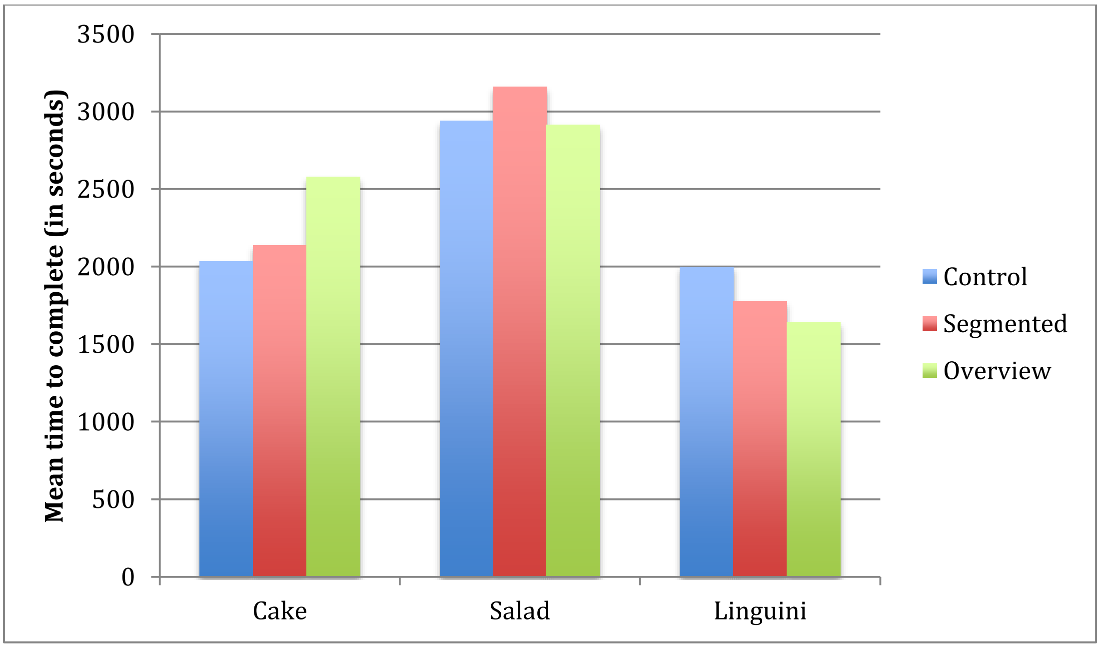

Figure 71: Mean time-to-complete the recipes by Recipe and Recipe Presentation

Table 48 shows the mean time the cooks took to complete the recipes. A two-way ANOVA for Latin squares found a main effect of Recipe, $F(2,2)=49.816$, $p=.020$ but none of Recipe Presentation, $F(2,2)= 0.658$, $p=.603$. There was no interaction between the Recipe and the Recipe Presentation $F(4,36) = .704$, n.s. There was an effect of cook $F(22,40) = 3.715$, $p=.000$.

This suggests that Recipe Presentation did not affect the efficiency of cooks in completing the recipes. To investigate if efficiency was in part due to individual differences of speed, i.e. if a cook was typically slow or typically fast in preparing recipes, the times to complete were ranked and the cooks in the fastest and slowest quartiles were compared.

Quartile	Cooks
Q1 (fastest)	1 cook for all 3 recipes
	1 cook for 2 recipes & 1 in Q2
	4 cooks for 2 recipes & 1 in Q4
Q2	
Q3	
Q4 (slowest)	1 cook for all 3 recipes
	4 cooks for 2 recipes & 1 in Q3

This suggests that some cooks were consistently slow in their preparation of recipes and others were consistently faster in their preparation. However the two cooks were appeared in the fastest and slowest quartiles suggests this is not a consistent pattern for all.

As this variation may reflect the relative experience and skill level of cooks the frequency of cooking and self rating of skills (as described in 7.2.2.1) of the fastest two cooks and the slowest five cooks was compared. The fastest cooks cooked most days of the week and rated their skills at 4: “can prepare a good range of dishes, occasionally try new techniques”. The slowest five cooks varied in their frequency of cooking and rated their skills at 3: “can prepare a simple meal without much problem” or 2: “know enough to get by”.

The frequency of cooking and self rated skills of the two cooks who were in the fastest quartile in two recipes and slowest in the other were the same as the two fastest cooks.

Time on screen of method instructions

Cooks have to integrate information from the detailed instructions provided in the method instruction steps with information in the ingredient list (for the Control and Segmented Recipe Presentations) and with information from the overview (Overview Recipe Presentation). In this analysis the time on screen of the detailed method instruction Steps was compared with the sum of time on screen of both method instruction steps and ingredient list or overview, i.e. the total time to complete.

Table 49: Mean Time-on-screen of method as percentage of time-to-complete

	Control	Segmented	Overview	Mean
Cake	66.50 (7.8)	68.15 (16.5)	26.6 (23.4)	**53.76 (25.5)**
Salad	53.33 (6.9)	61.03 (8.5)	29.45 (13.7)	**47.94 (16.8)**
Linguini	68.16 (15.3)	67.55 (15.8)	30.73 (19.9)	**55.47 (24.2)**
Mean	**62.66 (12.2)**	**65.58 (13.8)**	**28.94 (18.7)**	**52.39 (22.4)**

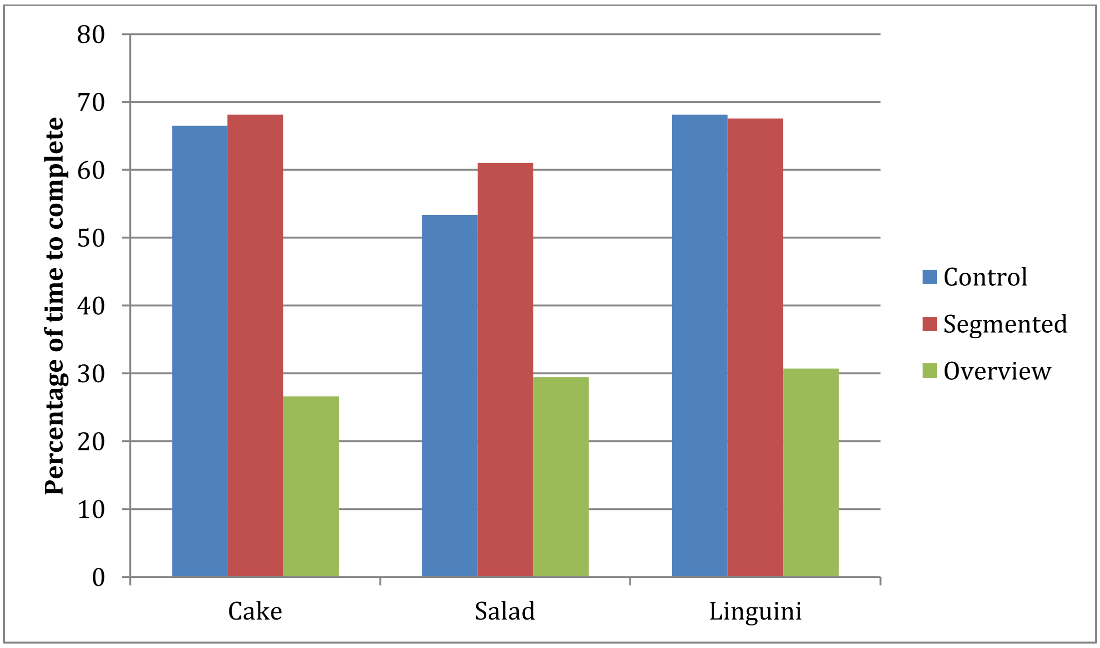

Figure 72: Percentage of time-on-screen for method instruction steps

Table 49 and Figure 72 show that the detailed method instruction steps were visible on screen for longer in the Control and Segmented Recipe Presentations than in the Overview Recipe Presentation.

A two-way ANOVA for Latin squares found there was a main effect for Recipe Presentation $F(2,2)=932.193$, $p=.001$. There was no main effect for Recipe $F(2,2)=0.601$, n.s. There was no interaction $F(4,36) = .515$, n.s. Post-hoc tests using the Tukey HSD indicated that the Overview Recipe Presentation was significantly shorter than both the Control and Segmented Recipe Presentations.

Time on screen of Steps

Each Step in the Control Recipe Presentation was split into several Steps in the Segmented-with-pictures and Overview Recipe Presentations.

Control	Segmented	Overview
1		1
	1	2
	2	3
	3	4
	4	5
	5	6
	6	7
	7	8
2	8	9
	9	10
	10	11
3	11	12
	12	13
	13	14
	14	15
	15	16

Figure 73: Corresponding Steps across Recipe Presentations for Cake Recipe

Figure 73 shows the corresponding Steps across the different Recipe Presentations for the Cake Recipe. For example it shows that Steps 1-7 in the Segmented Recipe Presentation corresponded to Step 1 in the Control Recipe Presentation. For this analysis the time-on-screen for the equivalent steps was summed and compared across Recipe Presentations in order to investigate if segmenting the instructions had an effect.

Table 50: Mean time-on-screen (SD) by method step in Cake recipe by Recipe Presentation, in seconds

	Control	**Segmented**	**Overview**	**Mean**
Step 1	691 (252)	847 (253)	440 (403)	**660 (343)**
Step 2	155 (187)	141 (147)	53 (77)	**116 (145)**
Step 3	481 (252)	505 (221)	232 (318)	**406 (284)**
Mean	**552 (317)**	**649 (357)**	**301 (329)**	**490 (348)**

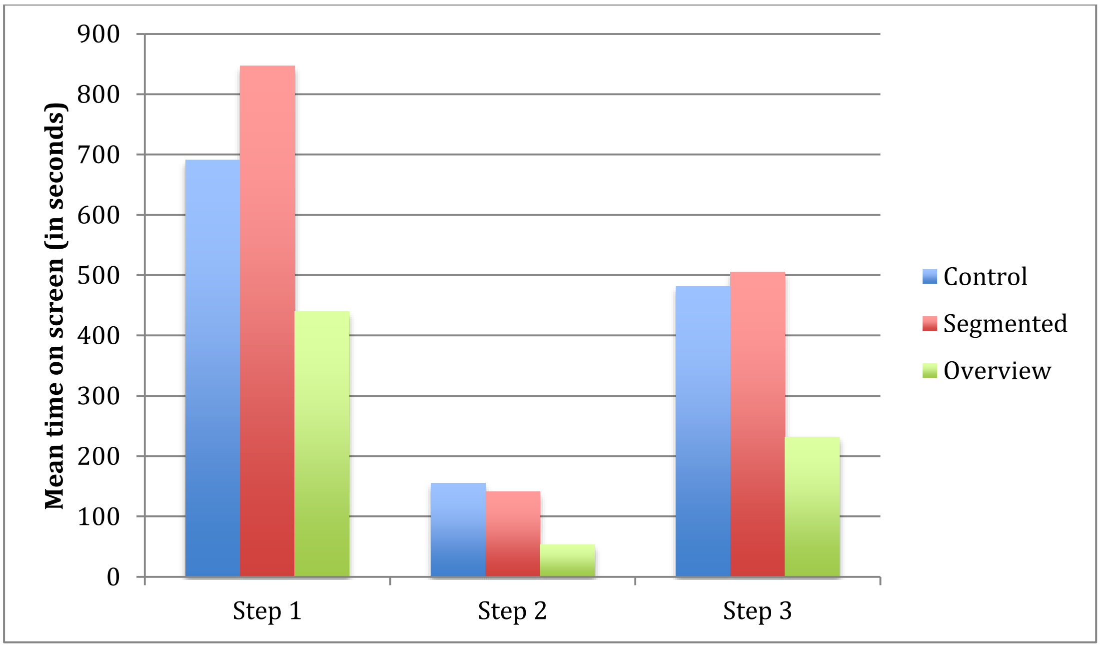

Figure 74: Mean time-on-screen by method step for Cake recipe by Recipe Presentation

Figure 74 shows that Step 1 of the Control Recipe Presentation was on screen longer than the other Steps and this was true also of the corresponding Steps in the other Recipe Presentations. For each Step, the time on screen was shortest in the Overview Recipe Presentation.

A two-way ANOVA with repeated measures found a main effect of Recipe Presentation $F(2,21)=4.870$, $p=.018$ and a main effect of step, $F(2,42)=35.814$., $p=.000$. The interaction between Recipe Presentation and step was not significant, $F(4,33)=1.101$,n.s.

Table 51: Mean time-on-screen (SD) by method step in Salad recipe by Recipe Presentation, in seconds

	Control	Segmented	Overview	Mean
Step 1	411 (306)	272 (183)	252 (170)	**311 (230)**
Step 2	240 (120)	275 (208)	234 (217)	**250 (179)**
Step 3	915 (235)	1400 (308)	419 (322)	**911 (495)**
Mean	**522 (368)**	**649 (589)**	**302 (249)**	491 (444)

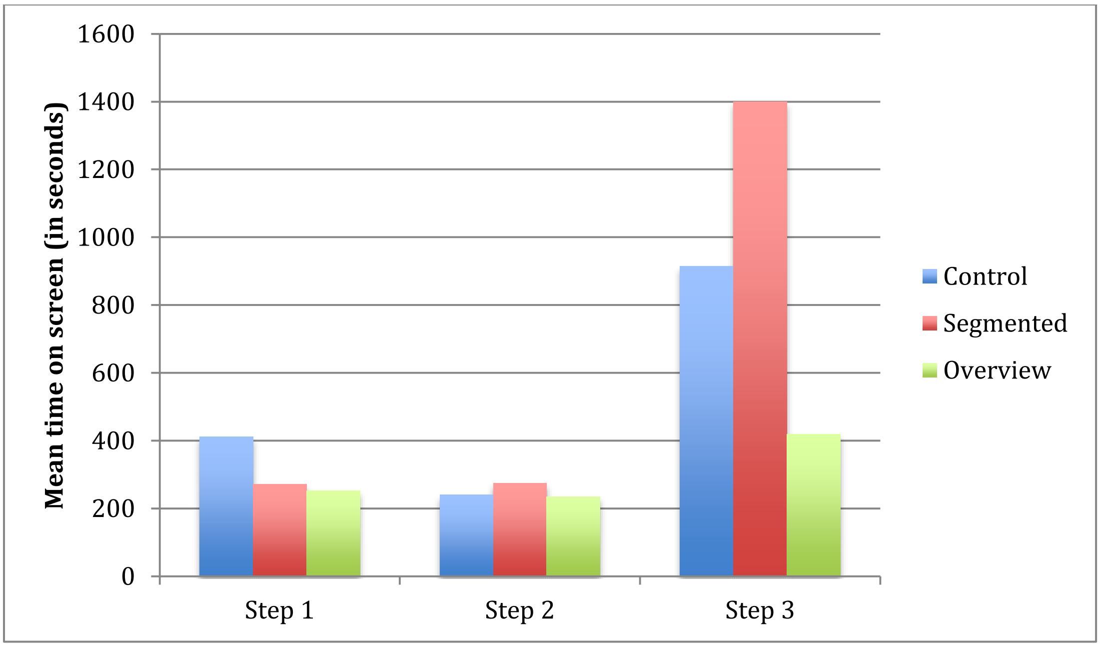

Figure 75: Mean time-on-screen by method step in Salad recipe by Recipe Presentation

Figure 75 shows that Step 3 of the Control Recipe Presentation of the Salad Recipe was on screen longer and this was true for the corresponding steps in the other Recipe Presentations also. For step 3 only, the time on screen was shortest in the Overview Recipe Presentation.

A two-way ANOVA with repeated measures found a main effect of Recipe Presentation $F(2,21)=10.358$, $p=.001$ and a main effect of step, $F(2,42)=63.891$, $p=.000$. The interaction between Recipe Presentation and step was significant, $F(4,42)=12.447, p=.000$.

Table 52: Mean time on screen (SD) by method step in Linguini recipe by Recipe Presentation, in seconds

	Control	Segmented	Overview	Mean
Step 1	69 (43)	64 (43)	71 (65)	**68 (49)**
Step 2	548 (230)	484 (202)	254 (225)	**429 (246)**
Step 3	318 (150)	316 (135)	151 (135)	**262 (156)**
Step 4	409 (211)	350 (179)	53 (71)	**271 (224)**
Mean	**335 (243)**	**303 (212)**	**132 (155)**	**257 (223)**

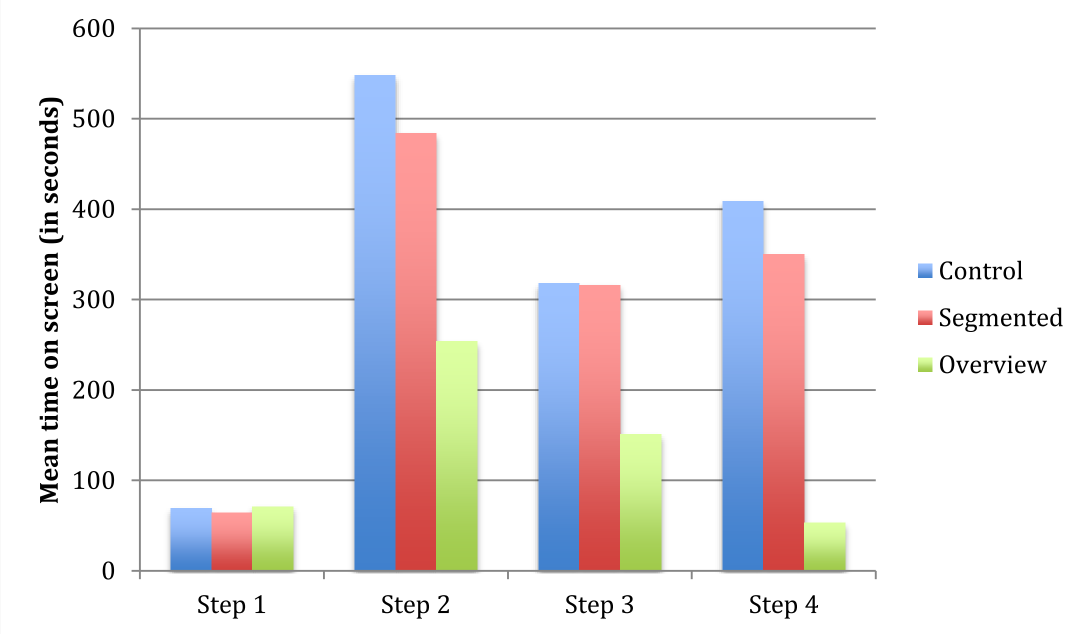

Figure 76: Mean time-on-screen by method step in Linguini recipe by Recipe Presentation

Figure 76 shows that Step 2 of the Control Recipe Presentation of the Linguini Recipe, and the corresponding Steps in each other Recipe Presentation was on screen longest, step 1 the shortest in all Recipe Presentations. For Steps 2 through 4, the time on screen was shortest in the Overview Recipe Presentation.

A two-way ANOVA with repeated measures found a main effect of Recipe Presentation $F(2,21)=10.228$, $p=.001$ and a main effect of step, $F(6,63)=26.065$, $p=.000$. The interaction between Recipe Presentation and step was significant, $F(6,63)=2.870, p=.016$.

7.3.1.2 Time-to-read the recipes

In order to investigate if Recipe Presentation affected how long cooks took to read the instructions the time to read was compared. Cooks interspersed reading the recipe with performing the tasks described in the recipe. Each reading event was captured by the camera located above the iPad and the duration of all reading events in a cooking session summed to provide the total reading time for the recipe for that cook.

Table 53: Mean time-to-read (SD) by Recipe and Recipe Presentation , in seconds

Presentation	Control	Segmented-with-pictures	Overview	Mean
Cake	338 (142)	299 (98)	269 (88)	**302 (110)**
Salad	413 (129)	481 (178)	501 (114)	**465 (142)**
Linguini	191 (49)	274 (105)	226 (95)	**231 (90)**
Mean	**314 (144)**	**352 (157)**	**332 (156)**	**333 (151)**

Table 53 shows the mean total reading time by Recipe and Recipe Presentation. An ANOVA found there was no main effect of Recipe Presentation, $F(2,2)=4.140$, p=n.s. The main effect of Recipe was significant, $F(2,2)=139.617$, $p=.007$. There was an effect of cooks $F(22,40) = 7.153$, $p=.000$. There were no other significant effects.

Post-hoc analysis using the Tukey HSD test indicated the Linguini recipe had the shortest total reading time compared to the Salad and Cake recipes but there was no difference between the total reading time of the Salad and Cake recipes.

7.3.1.3 Time-to-view the recipe pictures

Recipe steps in the Segmented Presentation and Overview Presentation were illustrated with pictures. Cooks tapped a link to view a picture associated with the step and tapped another to return to the recipe text. The frequency of picture views and the duration of these was extracted from the system logs.

Table 54: Mean time-on-screen (SD) of pictures by Recipe and Recipe Presentation, in seconds

	Segmented	Overview	Mean
Cake	146 (155)	451 (586)	**299 (443)**
Salad	182 (181)	404 (270)	**293 (250)**
Linguini	96 (100)	107 (160)	**101 (129)**
Mean	**141 (147)**	**320 (399)**	**231 (311)**

Table 54 shows the mean time on screen of the pictures by Recipe and Recipe Presentation. A two-way ANOVA for Latin square found no main effect for either Recipe, $F(2,2)=0.462$, n.s, or Recipe Presentation, $F(2,2)=40.280$, n.s. There were no other significant effects.

Table 55: Count of picture views (SD) by Recipe and Recipe Presentation

	Segmented			Overview			Mean	
	Views	**Pics**	**Views per picture**	**Views**	**Pics**	**Views per picture**	**Views**	**Views per picture**
Cake	8 (4)	10	.71 (.44)	10 (9)	11	.80 (.72)	**9 (7)**	**.76 (.57)**
Salad	12 (8)	8	1.34 (.90)	19 (3)	14	1.22 (.23)	**15 (7)**	**1.28 (.64)**
Linguini	6 (3)	6	.83 (.42)	8 (8)	10	.78 (.73)	**7 (6)**	**.90 (.57)**
Mean	**9 (6)**		**.96 (.66)**	**12 (8)**		**.94 (.61)**	**10 (7)**	**.95 (.63)**

Table 55 shows the count of picture views by Recipe and Recipe Presentation. The count of pictures associated with the recipe varied across presentation so the count of picture views per available picture is shown and submitted two-way ANOVA for Latin square. There was no main effect of either Recipe, $F(2,2)=10.906$, n.s, or Recipe Presentation, $F(2,2)=0.048$, n.s. There were no other significant effects.

Similarly, the mean time on screen per pictures available was calculated and submitted to a two-way ANOVA. No main effect was found for either Recipe, $F(2,2)=0.572$, n.s, or Recipe Presentation, $F(2,2)=8.617$, n.s. There were no other significant effects.

Picture time as proportion of total time to complete

Table 56: Mean Time-on-screen of pictures as percentage of time-to-complete

	Segmented	Overview	Mean
Cake	8.34 (9.8)	16.50 (18.1)	**12.42 (14.5)**
Salad	9.12 (12.0)	13.08 (6.4)	**11.10 (9.5)**
Linguini	5.41 (6.0)	6.22 (9.5)	**5.81 (7.7)**
Mean	**7.62 (9.3)**	**11.93 (12.6)**	**9.77 (11.1)**

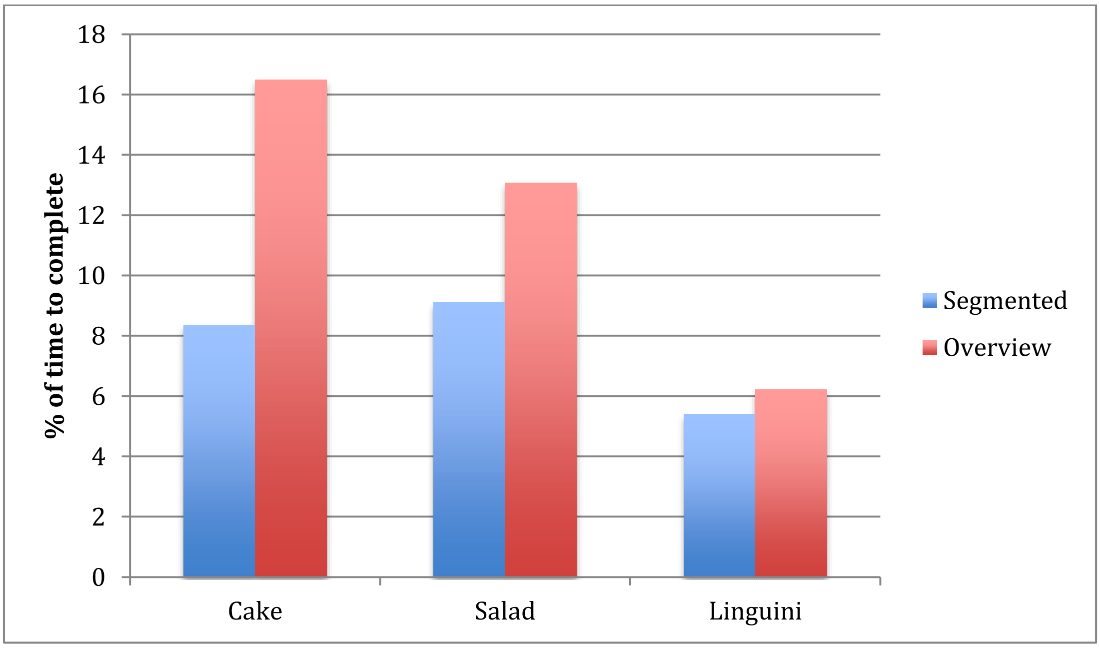

Figure 77: Mean time-on-screen of pictures as percentage of total time to complete

Table 56 and Figure 77 show the mean time on screen of pictures as a percentage of the total time to complete. A two-way ANOVA for Latin squares found a main effect for Recipe Presentation, $F(2,2)=13{,}155.7$, $p=.006$, and no main effect for Recipe, $F(2,2)=0.474$, n.s. There were no other significant effects. The results showed that cooks looked at pictures for a greater percentage of the time in the Overview Recipe Presentation. However this is to be expected as there more pictures in the Overview Recipe Presentation and the mean views per picture across all recipes remained stable (see Table 55).

To investigate if the variation in looking at pictures was due to individual differences, the counts of pictures viewed by each of the cooks was inspected and compared across the recipes.

- Six cooks looked at more than 10 pictures across both recipes
- Four cooks look at fewer than 5 pictures on either recipe
- Nine cooks looked at fewer than 3 pictures on the Linguini recipe

These observations suggest there may be a behavioural preference among cooks, some preferring to view more pictures than others.

7.3.2 Pre- and post-cooking questionnaires

7.3.2.1 Pre-cooking questionnaire

In order to investigate how difficult the cooks thought the recipes were and if this affected their confidence, the cooks were shown the title, headline paragraph and list of ingredients of the recipe before the cooking session and asked to rate how difficult they thought the recipe would be and their confidence in making the recipe on a scale of 1 to 7, where 7 was high.

Table 57: Mean ratings (SD) taken pre-cooking for recipe difficulty and confidence to make (7-point scale)

Rating	Recipe difficulty (higher is more difficult)	Confidence (higher is more confident)
Cake	2.42 (0.97)	5.58 (1.10)
Salad	3.42 (1.21)	4.75 (1.58)
Linguini	2.87 (1.45)	5.33 (1.47)
Mean	**2.90 (1.28)**	**5.22 (1.42)**

Table 57 shows the mean difficulty rating the cooks attributed to the recipes and mean confidence they had approaching the recipes. A one-way ANOVA showed that cooks rated the difficulty of the recipes differently, $F(2)=3.979$,

$p<0.05$, but found no difference between the recipes in the cooks' confidence in making them.

Post hoc comparisons using the Tukey HSD test indicated the salad recipe was rated more difficult than the cake recipe, but there was no difference in rating between the recipes for salad and linguini.

7.3.2.2 Relating pre-cooking ratings to cooks' skills

In order to investigate if cooks' skills affected how they rated the recipe difficulty and their confidence in making them their self rating was correlated with the ratings they gave in the pre-cooking questionnaire.

Cooks' skills and their rating of recipe difficulty

Cooks' self-rated their skills and stated how frequently they cooked in the participant profile questionnaire completed before attending the cooking session. The questionnaire is included in Appendix 5 and the results are detailed in section 7.2.2.1 of this chapter.

Table 58: Summary of correlations for recipe difficult rating and cooks' skills by Recipe

	Self rating of skills		**Frequency of cooking**	
Recipe difficulty rating	**r**	**sig**	**r**	**sig**
Cake	-.163	.448	-.357	.087
Salad	-.465	.022 *	-.497	.014 *
Linguini	-.267	.208	-.223	.295

Table 58 shows how the cooks' self-rating of skills (higher rating indicates more skill) correlated with the ratings of recipe difficulty (higher rating indicates more difficulty).

Cooks' skills and their confidence to make the recipes

Table 59: Summary of correlations for cooks' confidence and skills by Recipe

	Self rating of skills		**Frequency of cooking**	
Recipe confidence rating	**r**	**sig**	**r**	**sig**
Cake	.197	.357	.322	.125
Salad	.373	.072	.476	.019 *
Linguini	.123	.568	.463	.023 *

Table 59 shows how the cooks' self-rating of skills (higher rating indicates more skill) correlated with their confidence to make the recipe (higher rating indicates more confidence).

7.3.2.3 Post-cooking questionnaire

Immediately after each cooking session, cooks were asked to rate the Recipe Presentation and content on a range of measures and to provide free form comments describing what they liked most and least about the recipe.

The data for each rating were submitted to a two-way ANOVA for several Latin squares with three levels of Recipe Presentation (Control, Segmented-with-pictures and Overview) and three levels of Recipe (Cake, Salad, Linguini).

Table 60: Mean ratings (SD) taken post-cooking and F for effect of Recipe and Recipe Presentation

Item rated	Mean rating overall	F Recipe	sig	F presentation	sig
Confidence	5.21 (1.58)	4.607	.178	5.571	.152
Recipe difficulty	2.51 (1.33)	5.776	.148	2.946	.253
Well written	5.47 (1.38)	5.444	.155	10.949	.084
Well organised	5.21 (1.70)	12.290	.075	20.126	.047 *
Easy to understand	2.64 (1.60)	0.765	.566	4.156	.194
Sufficient info	3.81 (0.93)	0.392	.718	0.333	.750
Usefulness of pictures †	5.88 (1.14)	22.048	.043 *	9.000	.205
Sufficient pictures †	4.15 (0.71)	0.619	.618	3.240	.323

† Pictures were included only in the Segmented and Overview Presentations of the Recipes.

Table 60 shows the F ratio for the effect of Recipe and of Recipe Presentation for each of the ratings given in the post-cooking questionnaire. There was a significant main effect from Recipe Presentation on the rating for "well organised", $F(2,2)=20.126$, $p=.047$, detailed mean ratings are shown in Table 61. There was a significant main effect from Recipe on the rating for "usefulness of pictures", $F(1,2)=22.048$, $p=.043$, detailed mean ratings are shown in Table 62. No other effect was found.

Table 61: Mean ratings (SD) of recipe organisation by Recipe and Recipe Presentation

Recipe	Control	Segmented	Overview	Mean
Cake	5.37 (1.4)	4.88 (1.4)	6.25 (1.2)	**5.50 (1.4)**
Salad	3.63 (1.8)	3.75 (1.2)	6.63 (0.5)	**4.67 (1.9)**
Linguini	5.25 (1.9)	4.63 (1.9)	6.50 (0.9)	**5.46 (1.8)**
Mean	**4.75 (1.8)**	**4.42 (1.5)**	**6.46 (0.9)**	**5.21 (1.7)**

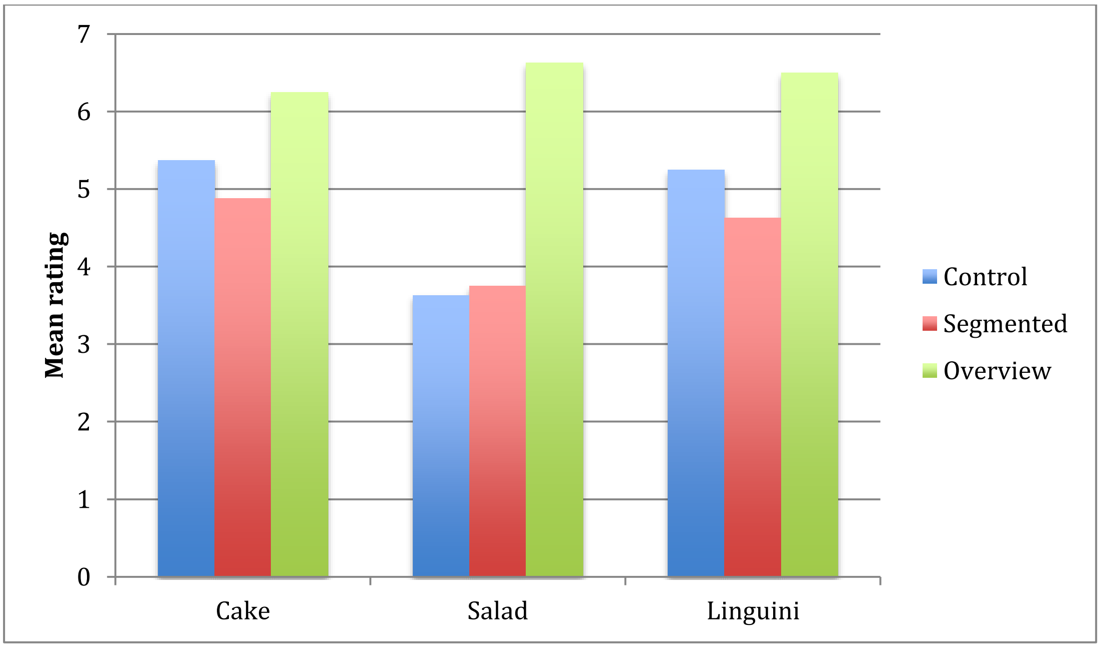

Figure 78: Mean ratings for recipe organisation

Table 62: Mean ratings (SD) of usefulness of pictures by Recipe and Recipe Presentation

Recipe	Segmented	Overview	Mean
Cake	5.75 (1.0)	6.00 (1.3)	**5.88 (1.2)**
Salad	6.38 (0.9)	7.00 (0.0)	**6.69 (0.7)**
Linguini	4.75 (0.5)	5.38 (1.2)	**5.06 (0.9)**
Mean	**5.63 (1.1)**	**6.12 (1.2)**	**5.88 (1.1)**

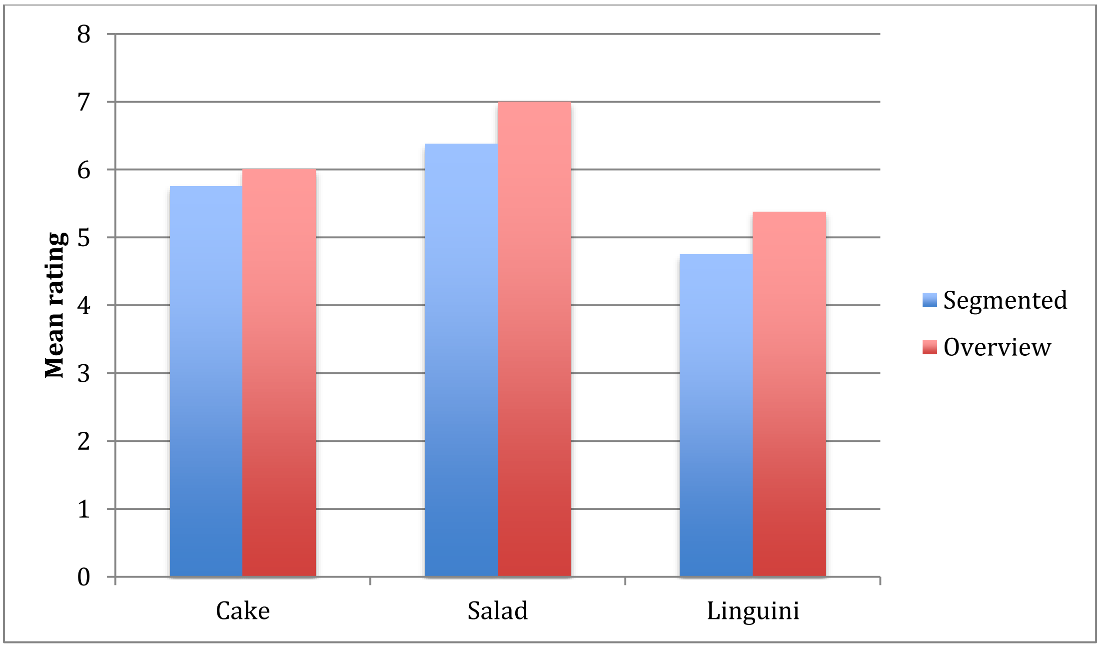

Figure 79: Mean ratings for picture usefulness

Table 61 and Table 62 show the mean ratings for well organised and usefulness of pictures. Figure 78 and Figure 79 illustrate these.

Post-hoc comparisons using the Tukey HSD test indicated the mean well organised rating for Overview Presentation (M=6.46 ,SD=0.88) was different from the ratings of Control (M=4.75, SD=1.82) and Segmented (M=4.42, SD=1.53) Presentations, but there was no difference between the ratings given for Control and Segmented Presentations. Post-hoc comparisons using the Tukey HSD test indicated the mean usefulness of pictures was different between all recipes, pictures being most useful for the Salad (M=6.69, SD=0.70) and least useful for the Linguini Recipe (M=5.06, SD=0.93).

Relating the ratings for well written, well organised and easy to understand

There was a significant correlation between the ratings cooks gave for well written (higher rating indicates better written) and well organised (higher rating indicates better organised), the obtained r_s = .47, p=.00 (two-tailed test). Relating the ratings for well written with these for easy to understand (lower rating indicates easier), the obtained r_s = -.410, p=.000 (two-tailed test). Relating the ratings for easy to understand with those for well organised, r_s = -.283, p=.016. Taken together these results indicate that cooks found recipes easier to understand when they were also well written and well organised.

7.3.2.4 Relating pre- and post-cooking ratings of recipe difficulty and confidence to make

In order to investigate if the experience of preparing the recipe affected cooks' confidence in making it or their rating of recipe difficulty, the ratings they gave in the pre-cooking and post-cooking questionnaires were correlated.

Table 63: Summary of correlations of pre- and post-cooking ratings by Recipe

	Confidence		Recipe difficulty	
Recipe	r	sig	r	sig
Cake	.334	.111	.501	.013 *
Salad	.476	.019 *	.304	.149
Linguini	.514	.010 *	.433	.034 *

Table 63 shows that relating the cook's ratings of recipe difficulty pre- and post-cooking, the obtained $r_s = .47$, $p=.00$ (two-tailed test), indicating that the experience of cooking the recipe did not change the cook's rating of its difficulty. Relating the cooks' ratings of their confidence to make the recipe pre- and post-cooking, the obtained $r_s = .45$, $p=.00$ (two-tailed test), indicating that making the recipe did not alter the cook's confidence to make it.

7.3.2.5 Cooks' post-cooking comments

Cooks were asked to describe in free text, what they liked most and least about the recipes and what, if any, additional information that would be useful. The comments were thematically analysed and organised by frequency.

Table 64: Cooks' post-cooking comments: What they liked about Recipe Presentations

Theme	Typical comments	Control	Segmented	Overview	TOTAL
Pictures associated with steps	"they reassured me a lot that I was doing the right thing" cook24	0	10	8	**18**
Easy access to ingredient list	"You could always go back to look at the ingredients list, easy to do and it allowed you to go back to the last step that you were on. That was useful." cook24	9	4	0	**13**
Timeline/flowchart layout of recipe	"I could easily prepare ingredients needed in later parts of the recipe well ahead of time" cook78	0	0	10	**10**
Paragraph steps as stages of the recipe	"Each stage was separate and so you felt like you had completed everything you had to before moving onto the next stage." cook23	9	0	0	**9**
Ingredients always on view and parallel to the instructions	"each ingredient is paired with what I am supposed to do with it" cook8	0	0	9	**9**
Short steps rather than paragraphs	"I liked the way in which there were lots of small, easy to use steps rather than a few steps with lots of instructions" cook18	0	8	0	**8**
TOTAL		**18**	**22**	**27**	**67**

Table 65: Cooks' post-cooking comments: What they disliked about Recipe Presentations

Theme	Typical comments	Control	Segmented	Overview	TOTAL
Ingredient list on a separate page	"You have to keep changing page if you forget the ingredients, especially the measurements. I hate that…" cook2	8	5	0	**13**
Steps on separate pages	"I like to be able to see where I am heading but when I flicked to the next step I forgot what I was doing on the step before it" cook11	4	3	2	**9**
Format does not support parallel working	"Whilst the potatoes were cooking I looked forward for other things to chop or do and then had to retreat when I needed reminding how long to cook them for" cook16	4	5	0	**9**
Format does not show location in recipe	"I would have liked an overview of how far I had progressed" cook17	2	3	0	**5**
Format had no pictures	"pictures would also be useful for helping to follow the instructions" cook6	4	0	0	**4**
Pictures and detailed instructions separately	"I would have liked the picture to come up at the same time as the more detailed text…it saves time clicking twice on steps you want extra help with" cook17	0	0	4	**4**
Lack of detailed description of technical terms	"I think maybe a few side-notes should be included for techniques on how to do things, but apart from that it was really good" cook6	0	0	4	**4**
TOTAL		**22**	**16**	**10**	**48**

Table 64 shows cooks' comments describing what they liked about the different Recipe Presentations. The most common theme was the pictures that appeared in recipes in the Segmented-with-pictures and Overview Recipe Presentations. Thirteen cooks said they liked the quick switch to the ingredient list in the Control and Segmented-with-pictures Recipe Presentations and six said they liked the ingredients associated with recipe steps in the Overview Recipe Presentation. Comments about step length were mixed with nine cooks who said they liked the short steps of the Segmented-with-pictures Recipe Presentation and nine who liked the longer paragraph steps of the Control Recipe Presentation.

Table 65 shows cooks' comments describing what they disliked about the Recipe Presentations. The most common recurring theme was they disliked having the recipe divided over separate pages be that ingredients, steps or pictures. In comments about the Control and Segmented-with-pictures Recipe Presentations cooks were also frustrated the formats did not support parallel working and efficient task organisation.

Table 66: Cooks' post-cooking comments: What additional information they wanted

Theme	Count	Typical comment
More description of technique or culinary terms	14	"How to peel a tomato!" cook20 "Meanings of al dente, sweat the garlic and sauté" cook14
Pictures on every step of the recipe	7	"As a less experienced baker, I found the pictures very helpful. On the few occasions when there weren't pictures attached, I felt less sure of how the food should look" cook20
Size of utensils	5	"what sized bowl required for each step might have been useful" cook11
Indicator of future stages	4	"minor issue: it should have been clear from the beginning to reserve some of the water after draining the pasta" cook9
Precise measures for ingredients	3	"it should also tell me how much walnuts to put in (in weight) the batter" cook8
Other comments	5	
TOTAL	**38**	

Table 66 shows the most common extra information that cooks wanted to see in their recipe.

7.3.3 Errors performed by cooks

In order to investigate if Recipe Presentation affected the rate of errors, the video recording of each cooking session was analysed to identify where cooks performed tasks incorrectly.

Table 67: Mean count of errors by cook (SD) by Recipe and Recipe Presentation

Recipe/Presentation	Control	Segmented	Overview	Mean
Salad	2.13 (2.1)	2.13 (1.5)	1.00 (.8)	**1.55 (1.5)**
Linguini	3.00 (3.2)	2.88 (15)	2.75 (2.4)	**2.88 (2.3)**
Cake	2.38 (2.8)	2.5 (1.1)	2.25 (1.9)	**2.38 (2.0)**
MEAN	**2.50 (2.6)**	**2.50 (1.1)**	**2.25 (1.9)**	**2.33 (2.0)**

Table 67 shows the mean count of errors performed by in each recipe by Recipe and Recipe Presentation. The data were submitted to an ANOVA[21]. There was no effect of Recipe Presentation, $F(2,2)=1.161$, n.s., there was no effect of Recipe $F(2,2)=1.982$, n.s. There was no interaction $F(4,36) = 1.191$, n.s.

Cooks performed a total of 158 errors, of these there were 47 instances where tasks were omitted, 46 where tasks were performed incorrectly, 62 where ingredient measures were performed incorrectly and 7 tasks were added.

The most common omitted tasks were: half the cooks (12) failed to cool the cake before icing it and ended up with icing that melted over the cake and seven cooks failed to save any pasta water in the Linguini recipe. In both cases the instruction to perform the task was not included in the same step as the other actions they were doing. In the cake recipe, the instruction to cool the

[21] Data were also submitted to Friedman's two-way ANOVA by ranks for nonparametric data, ignoring Recipe and matching cooks. No effect of Recipe Presentation was found

cake was in the same step as the instruction to cook the cake, not with the instruction to ice it. In the linguini recipe the instruction to use saved pasta water was in the step after the one that included the instruction to drain the pasta. As a result the cook did not see the relevant instruction at the time they were performing the task. The most common incorrect tasks were: Seven cooks added the eggs to the cake in one go (the instruction said to add gradually) and five cooks made the gremolata part of the salad recipe incorrectly. Of the ingredients incorrectly measured, most were in the Linguini recipe. Cooks did not measure the cheese, olive oil or wine included in this recipe.

7.3.4 Problems encountered by cooks

Transcripts were analysed to find problems where cooks were unable to complete a task without help or were delayed or frustrated in their attempt to complete a task.

Table 68: Mean problems by cook (SD) by Recipe and Recipe Presentation

Recipe Presentation / Recipe	Control	Segmented with picture	Overview	Mean
Salad	2.13 (3.0)	5.38 (4.4)	2.88 (1.6)	**3.46 (3.4)**
Linguini	2.13 (2.3)	2.50 (2.9)	0.88 (1.0)	**1.83 (2.2)**
Cake	3.13 (2.9)	2.75 (4.0)	1.75 (.9)	**2.54 (2.8)**
MEAN	**2.46 (2.7)**	**3.54 (3.9)**	**1.83 (1.4)**	**2.61 (2.9)**

Table 68 shows the mean count of problems encountered by cooks per recipe by Recipe and Recipe Presentation. The data were submitted to ANOVA[22].

[22] Data were also submitted to Friedman's two-way ANOVA by ranks for nonparametric data, ignoring recipe and matching cooks. No effect of Recipe Presentation was found

There was no effect of Recipe Presentation $F(2,2)=4.985$, n.s., there was no effect of Recipe $F(2,2)=0.888$, n.s. The interaction was not significant $F(4,36) = .656$, n.s. There was a significant effect of cooks $F(22,40)=2.913$, $p=.002$.

There were a total of 188 problems noted by cooks. These were thematically organised. 54 problems were related to the interactive system and 134 problems related to content of the recipe.

7.3.4.1 Problems relating to interaction design

In order to investigate the source of problems relating to interactive system these were further thematically organised.

Table 69: Frequency of problems relating to interaction design by Recipe Presentation

Category of problem	Control	Segmented	Overview	Total
iPad				
Needs clean hands	1	5	4	**10**
Zoom		2	6	**8**
Other	1		1	**2**
Steps/Ingredients on separate pages				
Ingredients/ Instructions	3	7		**10**
Instructions	2	8	2	**12**
Prep instructions/ Instructions		5	1	**6**
Overview			3	**3**
Instruction length	3			**3**
Total	**10**	**27**	**17**	**54**

Table 69 shows there were 28 occasions where having information on separate pages caused problems for the cooks and 20 occasions where the iPad caused problems for the cooks.

The most common problem described by cooks related to having information on separate pages and this was most commonly encountered using Recipes in the Segmented-with-pictures Recipe Presentation. Typical comments included: "OK so beat the butter and sugar together until light and fluffy but I can't remember the quantities so..." (cook 7) and “it doesn’t say how much there is [in the instruction] so I don’t know what size bowl to use” (cook 17). Cooks also noted they wanted information available to perform tasks in parallel for example cook 7 said “after four minutes, OK I see what you are doing recipe, yes I know, but I want to start making the butter cream whilst I am doing that”.

Cooks described problems interacting with the iPad because they had to wash their hands more often to use the recipe than they would if using a paper recipe. Typical comments included:

> “I guess this is something a little bit different to if I was using a paper recipe, I'm quite conscious of rinsing my hands before I touch the iPad because I know if it was mine I wouldn’t want to be constantly be [pause] whereas probably with a book I don't care, so most of them have smudges on and stuff over them” (cook 24).

7.3.4.2 Problems relating to recipe content

Cooks encountered problems with the recipe content in three ways; unfamiliar words or terminology, instructions that confused them and instructions that lacked sufficient information to enact. Overall there were 134 problems relating to recipe content mentioned by cooks.

Table 70: Count of problems due to recipe content by Recipe and Recipe Presentation

Recipe Presentation / Recipe	Control	Segmented	Overview	TOTAL
Cake	18	8	6	**32**
Salad	16	36	14	**66**
Linguini	16	13	7	**36**
TOTAL	**50**	**57**	**27**	**134**

Table 70 shows the Salad recipe caused nearly twice as many problems as either the Cake or Linguini recipes. Overall there was no difference between the Recipe Presentations except for the Salad recipe where the frequency of problems in the Segmented presentation was nearly twice that in the other presentations.

The most common problems with recipe content related to the Salad recipe and in particular the instructions to prepare the gremolata and the salad dressing. The tomato for the dressing was included in the ingredients list:

> *1 tomato, peeled and seeded*

The recipe step from the Control Recipe Presentation is shown below:

3. *For the gremolata, use a vegetable peeler to pare thin strips of rind from the lemon. Carefully remove as much white pith as possible (this is bitter). Finely chop the lemon rind and toss with the garlic and parsley. Season and set aside. Squeeze the juice from the lemon and whizz in a food processor with the peeled tomato and pesto for 10-15 seconds. Pour over the potato mixture and toss through. Scatter over the gremolata to serve.*

Typical comments included: "I don't know … it says in the, ah, no, OK, no I got it, no sorry I'm being an idiot… it says there was a peeled tomato but it wasn't under the gremolata bit, it was under the top bit so I was, I got confused cos I've been doing the lemon juice and stuff. Oh right. I need to peel this [tomato] don't I?" (cook 22). Cook 11 said "it's this extra random tomato that you have to peel and seed is slightly confusing, seems a waste, it doesn't explain why it needs to be peeled and seeded".

7.3.5 Behaviours with implications for design

The cooks' interactions with the recipes were visualised with progression maps. Progression maps, as used in the previous study, show the path the cooks took through the recipes, illustrating which recipe step or picture was visible at any time during the cooking session. For this study, the progression maps were drawn from interactions captured in the web logs and one was created for every cook and every cooking session.

The progress of the cook through the recipe can be followed on the progression map. Step 0 indicates the ingredient list (or base page for the Overview Recipe Presentation) and step 1 the first step in the method instructions. Following the progression of cooks through the recipes I identified several modes of interaction. Two of the modes identified in the previous study were seen again; *ingredient look up* and *look aheads* but no instance of *linear read-through* was seen. Progression maps of cooks' interactions with recipes in the Overview Recipe Presentation introduced two new modes I shall call *quick details* and *slow details*.

7.3.5.1 Reading pattern modes

Look aheads: Control and Segmented Recipe Presentations

The progression maps showed that cooks following recipes in the Control and Segmented-with-pictures Recipe Presentations looked at steps ahead of the current step.

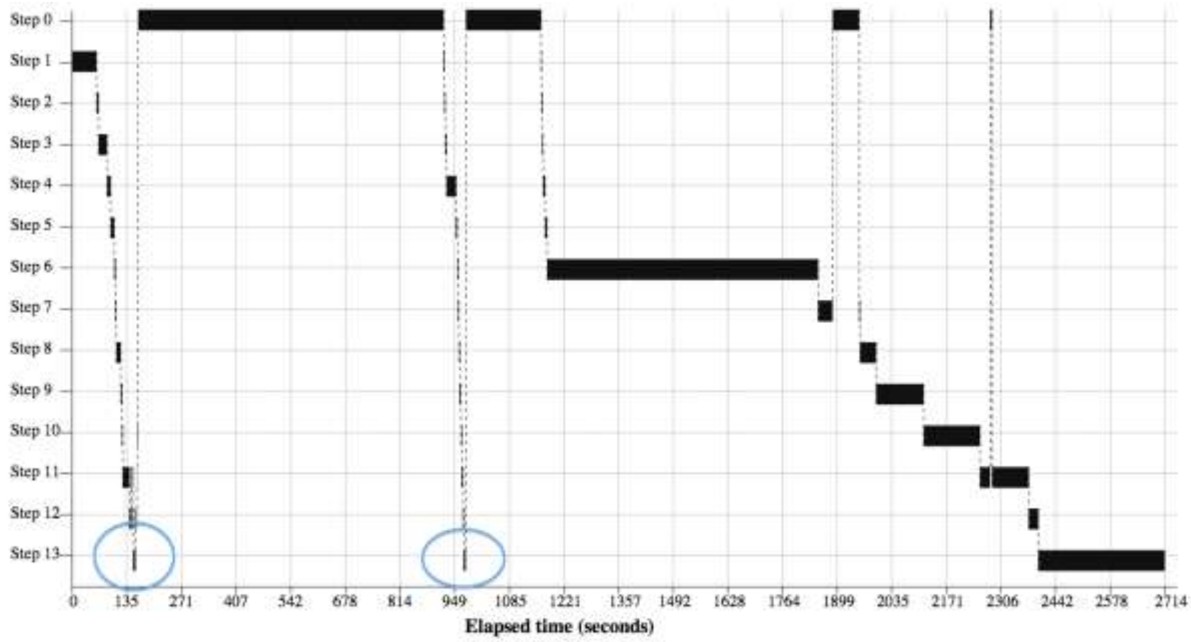

Figure 80: Progression map showing look-ahead activities: Cook 15 making Salad recipe in Segmented Recipe Presentation

Figure 80 shows the progression map of cook 15 preparing the Salad recipe. About two minutes into the session (140 seconds) the cook looked ahead through all the recipe steps (marked by blue circle), nods to himself and started to collect the utensils to be used later in the recipe. Again at about 15 minutes into the session (950 seconds) the cook looked ahead through the recipe and went to collect a large bowl to put the tomatoes in.

The look ahead activities seen in Figure 80 are clear and striking however most look ahead activities were only one or two steps ahead of the current step and sometimes followed with several flips backwards and forwards. I defined a look ahead activity as having occurred when a cook moved forward in a recipe and then back to an earlier step for more than 30 seconds. This was verified using the data from the web logs and the counts for each cook calculated for all cooking sessions in the Control and Segmented-with-pictures Recipe Presentations.

Table 71: Mean count of look-ahead activities by cook for recipes in Control and Segmented Recipe Presentations

Recipe	Control	Segmented-with-	Mean

		pictures	
Cake	1.75 (0.9)	2.63 (2.2)	**2.19 (1.7)**
Salad	1.63 (1.1)	4.00 (2.5)	**2.81 (2.2)**
Linguini	1.75 (1.8)	4.00 (1.4)	**2.88 (1.9)**
Mean	**1.71 (1.2)**	**3.54 (2.1)**	**2.63 (1.9)**

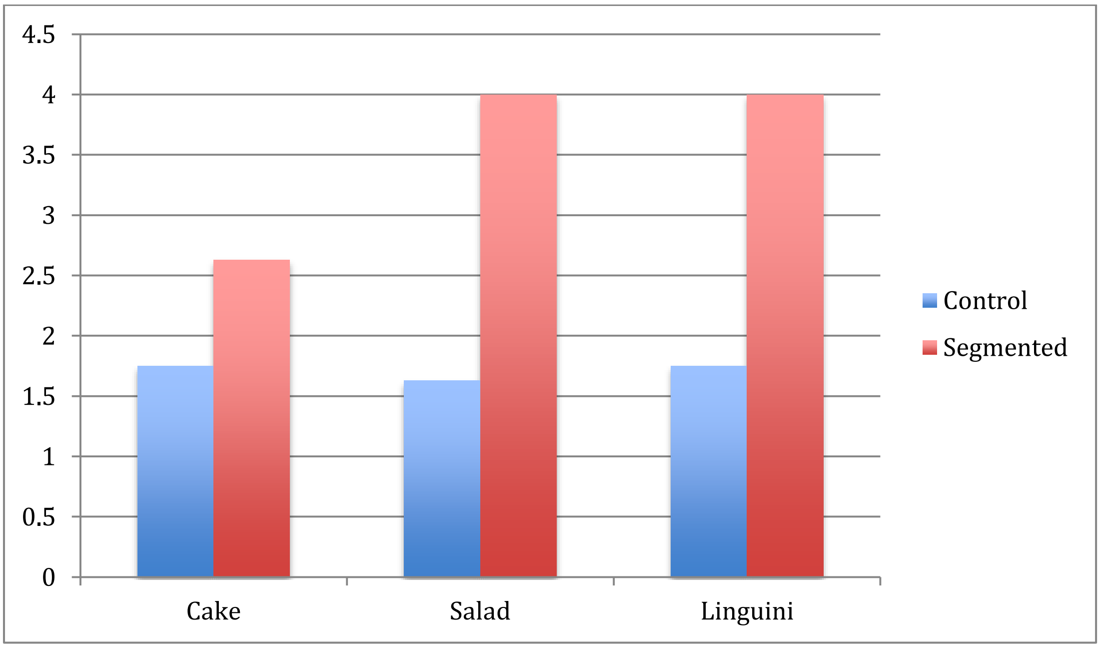

Figure 81: Mean count of look ahead activities

Table 71 and Figure 81 show the count of look ahead activities performed by cooks preparing recipes in the Control and Segmented-with-pictures Recipe Presentations. A two-way ANOVA found a main effect of Recipe Presentation, $F(1,45) = 13.8$, $p<.001$. There was no main effect of Recipe, $F(1,45)=1.3$, $p<.26$. There were no other significant effects.

Table 72 shows typical comments made by cooks when they looked ahead in the recipe. Cooks looked ahead most commonly when they were waiting for something to cook, for instance the pasta and mince in the linguini recipe, potatoes in the salad recipe and cake in the cake recipe. On a few occasions, as shown in the work ahead category, cooks sought out additional tasks to perform in parallel such as grating cheese or chopping parsley. The comments also show that cooks flicked through the recipe to plan when they would collect ingredients and perform the preparation tasks.

Cooks' comments about look ahead events

Table 72: Cooks' comments about look-ahead activities

Category of comment	Count	Typical comment
Browsing while waiting for something to cook	17	"hmm [potatoes] still cooking, let's see what's next" (cook 14, salad segmented)
		"ok, just having a flick through what the rest is to do" (cook 24, linguini segmented)
Planning collecting ingredients and preparing them	10	"what comes next then? I'm thinking about what I should prepare next" (cook 20, salad control)
		[with wine in hand, checks when wine appears in recipe] "I will measure it later" (cook 13, linguini control)
At start, reviewing the recipe and collecting utensils	6	"so how do I do this? So I'm going to cook the pasta first…" (cook 12, linguini segmented)
		cook gets colander out and says "will need that later" (cook 10, salad control)
question about state	4	"hmm, I'm wondering how thoroughly they [potatoes] need to be scrubbed, does it say on the next page?" (cook 12, salad control)
		"just want to check I don't have to use these [tomato seeds] before I throw them away" (cook 1, salad segmented)
Work ahead while things are cooking	4	"just going to chop, chop my parsley" (cook 16, linguini control)
		"now to read the bit between the potatoes and the tomato bit so I can do something whilst they are boiling" (cook 16, salad segmented)
Total	**41**	

Ingredient look ups: Control and Segmented Recipe Presentations

The progression maps showed that cooks following recipes in the Control and Segmented-with-pictures Recipe Presentations switched from the current recipe step to the ingredients list several times through the cooking session.

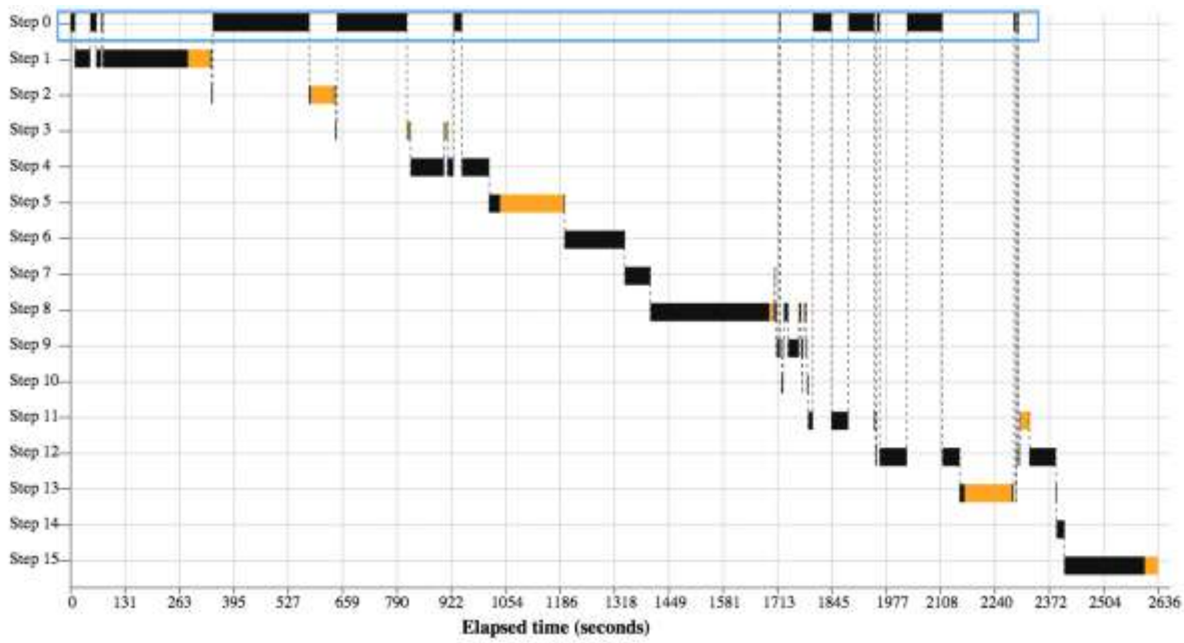

Figure 82: Progression map showing ingredient look-up activities: Cook 20 preparing Cake recipe in Segmented Recipe Presentation

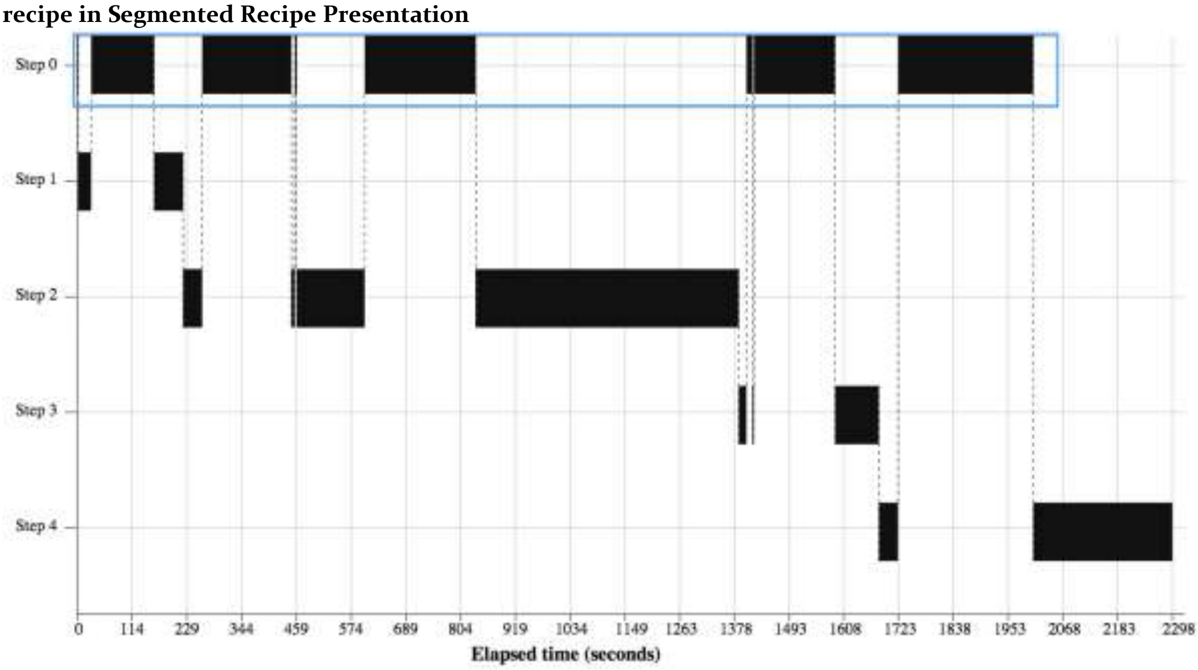

Figure 83: Progression map showing ingredient look-up activities: Cook 14 preparing Linguini recipe in Control Recipe Presentation

Figure 82 and Figure 83 show progression maps in both Control and Segmented-with-pictures Recipe Presentations where cooks switched attention to the ingredients lists several times during the preparation of the recipe.

Quick details: Overview Recipe Presentation

The quick details mode was seen only for recipes in the Overview Recipe Presentation. It was characterised by two factors; for the majority of the cooking session the base overview screen was visible and of the occasions the cook looked at the detailed recipe steps the majority of looks were less than 10 seconds.

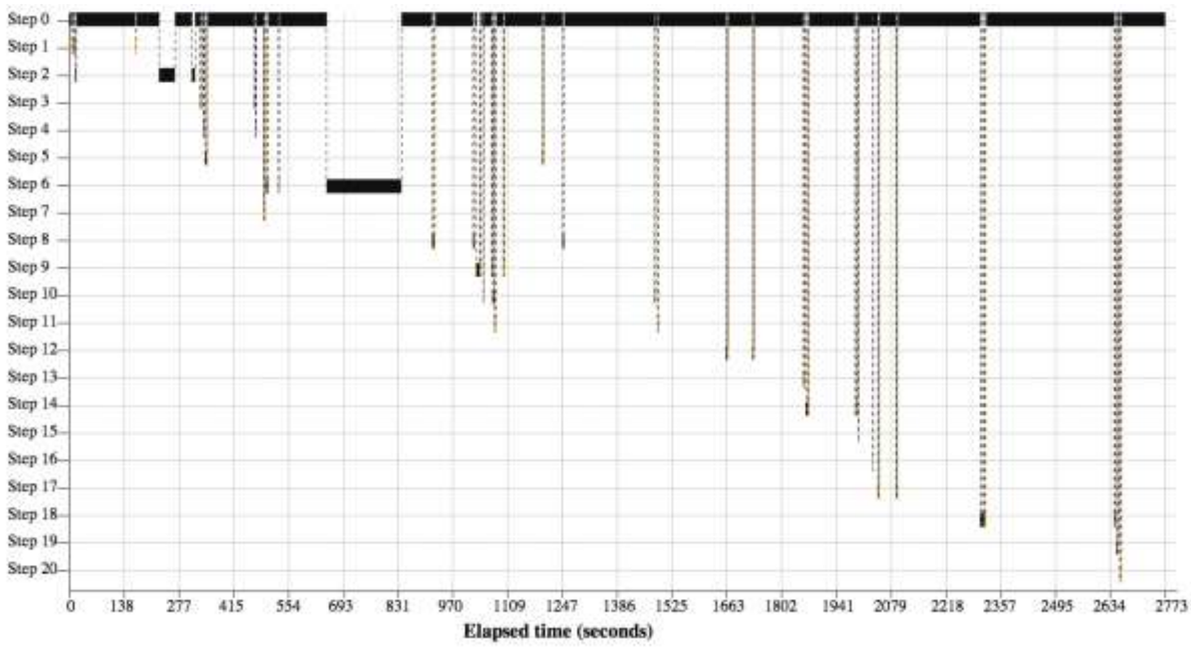

Figure 84: Progression map showing *quick-details* look-up activities: Cook 21 preparing the Salad recipe in Overview Recipe Presentation

Figure 84 shows cook 21's progression through the salad recipe. For the majority of the cooking session the base overview was visible on screen (the bar at the top) and the cook made frequent switches to the detailed recipe steps, the majority of which lasted for durations of less than 10 seconds. Step 2 was visible for 51 seconds and step 6 for 196 seconds during this cooking session.

Cooks following recipes in the Overview Recipe Presentation looked at detailed recipe steps mean=14 times per cooking session, 7.5 (54%) of these looks were for less than 10 seconds. Fourteen cooks were characterised as using the quick details mode because the majority of their looks at detailed recipe steps were for less than 10 seconds.

Slow details: Overview Recipe Presentation

The *slow details* mode was seen only for recipes in the Overview Recipe Presentation. In contrast to the *quick details* mode, the detailed recipe steps and pictures were visible on screen for longer periods of time, with a mean of over 30 seconds.

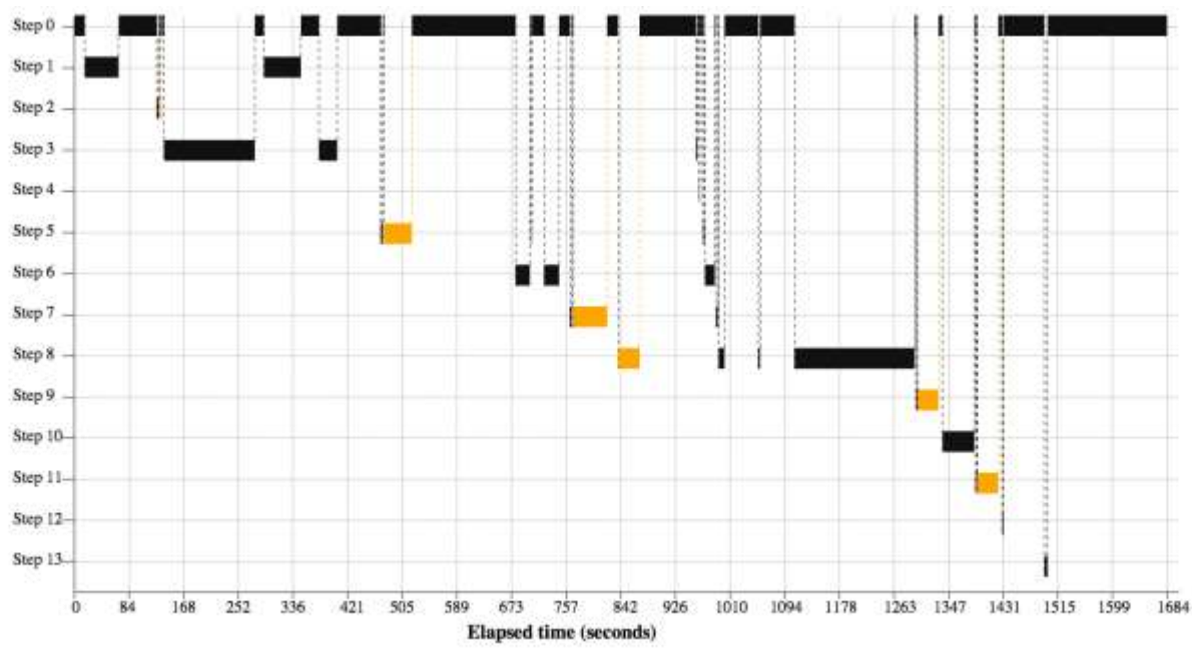

Figure 85: Progression map showing slow-details look up mode: Cook 2 making Linguini recipe in Overview Recipe Presentation

Figure 85 shows cook 2's progression through the Linguini Recipe in the Overview Recipe Presentation mode. As with the quick details mode, for the majority of the cooking session the base overview was visible on screen, but in contrast with the quick details mode, when the cook switches to the detailed recipe steps they are visible for durations of 30 seconds or more.

Ten cooks were characterised as using the slow details mode and had a mean duration per step of more than 60 seconds.

The cooking sessions were analysed to identify behaviours with implications for design relating to use of ingredient lists, sequential steps and pictures.

7.3.5.2 Measuring and preparing ingredients

Transcripts were analysed to identify how cooks collected, measured and prepared the ingredients.

Table 73: Count of ingredient behaviours by Recipe and Recipe Presentation

	Control			Segmented			Overview		
	Mep	**Coll**	**JIT**	**Mep**	**Coll**	**JIT**	**Mep**	**Coll**	**JIT**
Cake	0	3	5	0	4	4	0	1	7
Salad	1	0	7	2	1	5	0	0	8
Linguini	1	3	4	4	1	3	1	0	7
Total	**2**	**6**	**16**	**6**	**6**	**12**	**1**	**1**	**22**

Table 74: Count of ingredient behaviours by Collection method and Recipe Presentation

Ingredient collection method / Recipe Presentation	**Mep**	**Coll**	**JIT**	**Total**
Control	2	6	16	**24**
Segmented	6	6	12	**24**
Overview	1	1	22	**24**
Total	**9**	**13**	**50**	**72**

Table 73 shows the ingredient behaviour of the cooks organised by Mise-en-place (Mep), Collected ingredients early (Coll) and prepared Just-in-Time (JIT) by Recipe and Recipe Presentation. Table 74 shows the same data by Ingredient Collection Method and Recipe Presentation.

The tables show that the majority of cooks collect, measure and prepare the ingredients for recipes on a just-in-time (JIT) basis. In 9 cooking sessions cooks collected and prepared all the ingredients before starting the recipe steps, in 13 they collected the ingredients and then measured and prepared them as they proceeded with the recipe.

Some cooks talked about mise-en-place as if it was an obligation. For example cook 15 said “I'll do all the chopping first, decided I won't stress myself out this time and I won't try to do everything at once, do all the chopping beforehand *like you are meant to*" (cook15 making linguini) but, in common with other cooks abandoned the mise-en-place approach when they saw a task that could be performed in parallel such as cooking the pasta. Similarly, Cook 12 said "*I know I said I was going to get all the ingredients ready first but now I am wondering*, put the mixed tomatoes, well actually it's just a salad so it doesn't matter if things get cold...I'm just going to start on the potatoes and beans first, but it does say that I need the beans so I am going to get them ready beforehand".

7.3.5.3 Task sequence

All cooks were observed to perform tasks in parallel at least once during the cooking sessions. The transcripts were analysed to find instances where cooks read ahead to find other tasks to perform and made it clear through utterances they were performing tasks in parallel.

Table 75: Count of parallel task behaviours by Recipe and Recipe Presentation

Recipe	Control	Segmented	Overview	Total
Cake	9	2	5	**16**
Salad	4	6	8	**18**
Linguini	6	6	5	**15**
Total	**19**	**14**	**18**	**49**

Table 75 shows that cooks performed tasks in parallel in all recipes and all Recipe Presentations. The behaviour was most common when something was cooking, for example the potatoes in the salad recipe, the pasta in the linguini recipe or the cake in the cake recipe. When the potatoes had started to cook, cook 7 said "now I have nothing to do until that finishes so I can start preparing the tomato". When the cake was cooking, cook 22 said "so I look at the next step, make, meanwhile! I'm checking after that's all done so... I have two minutes to make the coffee butter cream".

Cooks were also observed to interrupt their tasks, for example cook 11 (using the salad recipe in Control Recipe Presentation) stopped making the gremolata when the timer alarm indicated the potatoes were done, and he only returned to the gremolata after draining and rinsing the potatoes.

7.3.5.4 Use of pictures

Cooks used the pictures provided in the Segmented and Overview Recipe Presentations. Pictures were not shown by default but cooks were free to tap a “picture” button to see the picture related to the current step. The transcripts were analysed for instances where cooks made comment about the picture and the use they were making of it.

Table 76: Count of picture use behaviours by Recipe and Recipe Presentation

	Segmented			Overview		
Picture use behaviour / Recipe	**Goal**	**Comp**	**Infl**	**Goal**	**Comp**	**Infl**
Cake	2	6	7	4	8	3
Salad	5	0	0	9	2	1
Linguini	3	3	0	2	1	0
Total	**10**	**9**	**7**	**15**	**11**	**4**

Table 77: Count of picture use behaviours by Recipe Presentation

Recipe Presentation / Picture use behaviour	**Segmented**	**Overview**	**Total**
Goal	10	15	**25**
Compare	9	11	**20**
Influenced	7	4	**11**
Total	**26**	**30**	**56**

Table 76 shows the count of picture use behaviours by Recipe and Recipe Presentation. Table 77 shows the same data summed by behaviour type and Recipe Presentation.

The tables show that cooks most used pictures both help them before they started a task to know what the goal state they were aiming for and then also to compare the current state of their mixture against. Eleven cooks were observed to be influenced by the pictures.

Twenty-five instances were observed where cooks looked at pictures to determine the goal state of the current step, i.e. to see what they were aiming at. Cook 16 said “I should bring up the picture and try to get mine to look as much like the picture as possible, it's getting there now”. Cook 24 said "so 2 salad onions, thinly slice 2 salad onions erm, and there is a picture on there how to do it”. Cook 14 said as he looked at picture for dressing "does it have a picture of what it's supposed to look like? I've got to have the pesto which is in the fridge, ok it's supposed to look like that”.

On twenty instances, cooks were observed to use pictures to compare the state of their ingredients or mixture, for example, cook 7 said "ooh there's a picture as well, I forgot about that. [looks at cake] yeah I think mine looks vaguely like that”, cook 21 said "and sweat the garlic, picture of it, that looks like mine so I feel alright”.

Where pictures influenced cooks it was mostly in their choice of utensils to use in the task. For example, while making the icing for the Cake recipe, cook 19 said "beat until smooth, I have a picture, it wants me to use this purple thing [spatula]” and cook 22 selected a bowl based on the picture "I think I chose this bowl because it was on the picture, it's the medium glass bowl, is a glass one as well”.

7.4 Discussion

In this study 24 cooks prepared three recipes from three different interactive formats: Control (traditional Recipe Presentation), Segmented-with-pictures and Overview. The study was designed to investigate the research questions: (1) how do pictures affect how cooks interact with recipe instructions? and (2) how does an overview of recipe structure affect how cooks interact with recipe instructions?

7.4.1 Cooks' interactions with recipes in Control Recipe Presentation

Recipes in the Control Recipe Presentation were presented in the traditional recipe format, i.e. as they were published. The recipes had a separate ingredient list with preparation instructions and method instruction steps in paragraphs of various lengths.

In the post-cooking questionnaire, cooks did not rate recipes in the Control Recipe Presentation differently from those in the Segmented-with-pictures Recipe Presentation. In their feedback, cooks said they liked the paragraphs because there were "many steps on the same page. It helps me keeping track of what I am doing" (cook 5). As many cooks liked the one tap option to see the ingredient lists as disliked having to tap to see the ingredients at all. Cooks similarly did not like having steps on separate pages "as I couldn't see all the steps at once it was difficult to get an overview of all of the steps" (cook 24) and they pointed out that "had I not [scanned through] I would not have noticed a step that was to do something 'meanwhile' waiting for something else to happen" (cook 24). In other words cooks found problems with instructions on separate pages because they could not gather an overview of the recipe and did not quickly see where tasks could be performed in parallel. This point will be expanded further in the next section.

As observed in the previous study, cooks did not read the recipe in sequence. They looked ahead in the recipe a mean of 1.7 times per recipe. Most cooks measured and prepared their ingredients as they appeared in the method instructions, i.e. the cooks did not mise-en-place. These findings support those of the previous study that cooks do not read recipe instructions in sequence, they do not mise-en-place and they attempt to perform tasks in parallel.

7.4.2 Effect of Segmented-with-pictures Recipe Presentation

The Segmented-with-pictures Recipe Presentation differed in two aspects from recipes in the Control Recipe Presentation, pictures were added to the text instructions and the instructions were segmented into short steps.

Compared to recipes in the Control Recipe Presentation cooks did not rate them any differently, there was no difference in the time to complete the recipe or read the recipe and there were no fewer errors or problems overall. Compared with recipes in the Control Recipe Presentation, cooks giving feedback in the post-cooking questionnaire said they liked the pictures and the shorter steps.

7.4.2.1 Adding pictures

Cooks viewed pictures for 8% of the time-to-complete the recipe looking at each picture once on average. The transcript analysis highlighted that pictures were used in two different ways; before starting a task in order to set the goal and during or at the end of a task to compare the current state of the ingredient with that shown in the picture.

When cooks used the pictures to set goals they typically viewed the picture before starting the task, or early on in the task, to supplement the textual instruction. For example cook 24 said “so [reading] ‘two salad onions, thinly sliced’, two salad onions, erm, and there is a picture on there how to do it”. Cook 16 here describes how pictures were used as the goal to aim for “I should bring up the picture and try to get mine to look as much like the picture as possible”.

When cooks used the pictures to compare the state of their ingredients they were either part way through or had nearly completed the task. The pictures were used as reassurance that the task had been performed correctly, for example cook 7 said “yeah I think mine looks vaguely like that” and cook 21 said “that looks like mine so I feel alright”. The reassurance the pictures gave was confirmed in the post-cooking questionnaire. Eighteen cooks said pictures were what they liked most about the recipes, for example “pictures were very useful affirmation that I was on the right track” (cook 11) and “they reassured me a lot that I was doing the right thing” (cook 24).

Adding pictures to instructions has been found to help users because it enables users to directly compare the picture with the state of the system they are working on (Van der Meij & Gellevij, 2004). Adding pictures to recipe instructions may help cooks, particularly where they need to interpret a goal state of an ingredient. For example, Mennicken et al. (2010) included pictures in *PersonalChef* because they would help cooks see how brown onions should be when caramelised (p3404). In the previous study, cooks had problems interpreting instructions for preparing ingredients such as slicing peppers and as a result they made an error and chopped the peppers instead of slicing them. In this study then, it was anticipated that including pictures would reduce the problems encountered and the errors performed by cooks, however, a number of cooks did not look at many pictures and this may have reduced the ability to measure a difference. There was no difference in the count of problems or errors compared with cooks using recipes in the Control Recipe Presentation.

The lack of significant differences may be because the pictures were not sufficiently task-appropriate (Schnotz and Bannert, 2003). In this study the photographs were of the goal state of the step and did not attempt to illustrate technique with still images, others have taken different approaches. Earlier researchers used a range of illustrations in their systems, for example cartoon style images of utensils in *HappyCooking* (Hamada et al. 2005), still photographs of ingredients and utensils in *CounterActive* (Ju et al. 2001) and *PersonalChef* (Mennicken et al. 2010) and videos showing techniques in

PersonalChef and *Panavi* (Uriu et al 2012). This is the first time, however, that recipes steps with photographs of the goal state of the step have been evaluated against textual recipes. The findings show that cooks liked having the pictures but in this study they did not reduce the number of problems and errors for the cook. As cooks used pictures for different purposes, it may be useful for future research to investigate the type of content of pictures that would best benefit cooks.

7.4.2.2 Segmenting instructions

The pictures in the Segmented Recipe Presentation were received warmly but the short segmented steps were not. In the post-cooking questionnaire feedback, nine cooks said they liked the short steps because they were "lots of small, easy to use steps rather than a few steps with lots of instructions" (cook 18). More cooks, however, said they disliked the short steps because they were on separate pages that made it difficult to find tasks to perform in parallel, for example cook 12 said "having it on separate pages meant I kept having to look forward to remind myself whether anything else needed doing (while the meat was cooking for example)".

Confirming the findings of the previous study, cooks looked ahead more often in recipes in the Segmented Recipe Presentation than those in the Control Recipe Presentation. As a result they had to tap the iPad more often. Although the overall count of problems was no higher in the Segmented Recipe Presentation a number of cooks had problems related to using the iPad because their hands were mucky with ingredients.

Considering the design selected for recipe steps in this and the previous study, an objection could be raised that problems were introduced because of one aspect of the design namely that each step was shown on a separate page that was mentioned as a problem by cooks (see Table 65). These problems may have been sufficient to mask a positive effect of shortening steps and adding pictures. In defence of this design, however, presenting the recipe steps in this way provides this study two advantages over previous designs; firstly it follows established methodologies for investigating what aspects of instructions users look at and the path they take through instructions (Karreman & Steehouder, 2004) and secondly it mimics the design of a number current commercial recipe applications designed for small mobile devices. Figure 87, for example, shows a recipe using the Nigella's cooking application[23] for the iPhone. Each short step is presented individually with the ingredient information on a separate tab. Given the small screen estate of a mobile device and the context in which recipe steps will be used, i.e. in the kitchen, from a longer distance than the screen would normally be read, larger text and less content per page is a necessary design consideration. Similarly, Figure 86, shows the BBC Good Food recipe app[24] with the ingredient list on a separate page from the method instructions. Cooks who use these recipe applications have to tap the screen to move between instructions and ingredients as they did in this study.

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[23] http://www.nigella.com/nigella-apps/nigella-quick-collection-for-iphone-3

[24] http://www.bbcgoodfood.com/good-food-mobile-apps

Figure 86: BBC Good Food application showing separate ingredient list

Figure 87: Recipe steps from Nigella's recipe application for iPhone

The results of this study show that cooks do not follow recipe instructions in a linear and sequential manner. Indeed they show that the content of recipes and the way cooks address the tasks within precludes a design that assumes linear and sequential access of steps from being a success. The addition of pictures to supplement the textual instructions is not shown to overcome these problems. These findings suggest that contemporary recipe apps for mobile phones that present instructions in sequential manner on different pages and with ingredient lists on separate pages do not support cooks in the way they interact with recipe instructions.

7.4.3 Effect of Overview Recipe Presentation

In the Overview Recipe Presentation the overall structure of the recipe procedure was presented in a flow chart form. Each branch of the flow chart represented a component or sub-goal of the recipe. In the flow chart, the method instruction steps were represented with brief extracts of the full instruction, the cook tapped the extract to view the full textual instruction. Next to the brief instruction was a picture icon the cook could tap to see a picture of the goal state of the instruction. Preparation instructions were incorporated into the method instructions just before the ingredient was used. The ingredients list was shown in a column on the left hand side, with ingredients grouped and aligned aside the step to which they were used.

Cooks gave recipes in this Recipe Presentation the highest rating for well organised instructions and this rating was correlated with individual ratings for well written and easy to understand. Ten cooks said the flowchart layout was what they liked most about the recipe because, as cook 6 said it “made it easier to follow than step-by-step instructions” and it allowed cooks to plan and perform tasks in parallel, for example cook 7 said “I could easily prepare ingredients needed in the later parts of the recipe well ahead of time”.

Despite this ability to plan their tasks, the Overview Recipe Presentation made no difference to the time taken to complete the recipe. This was in part due to the variation among cooks taking part in the study; some cooks were typically faster than others in preparing all the recipes. The results suggest there may be a relation with the cooks' self rating of skills and their cooking frequency that future research could investigate.

Considering the task flow of cooks when making the recipe, again there was no difference in the number of tasks performed in parallel but feedback given in the post-cooking questionnaire suggested the Overview Recipe Presentation supported the behaviour better. Cook 17 said it was "really clear to see the rationale behind the timings, which makes me confident the recipe is telling me to do the right thing. If I want to shift things around a little, it also gives me all the information I would need to do that". In this study, as in the previous, few cooks prepared their ingredients before starting the method instructions. In the Overview Recipe Presentation, only 1 cook took a mise-en-place approach, 22 measured and prepared their ingredients as they followed the recipe instructions, cook 4 said "I liked how you could see the ingredients and the instructions side by side. Made the recipe very easy to follow and cook".

The Overview Recipe Presentation made no difference to the time taken to complete the recipe or the total time taken reading the recipe instructions but the time spent looking at instructions was different from the other Recipe Presentations. Starting at the Overview page, cooks tapped a link to trigger a pop up to show the detailed method instruction step or a pop up showing the associated picture. Pop up instructions were visible for an average of 29% of the time. This was less than half the time that method instruction steps were visible when cooks used recipes in the other Recipe Presentations. This was in small part because there were more pictures in the Overview Recipe Presentation and cooks viewed pictures at the same rate as they did in the Segmented-with-Pictures Recipe Presentation. The main difference in viewing time of instructions was because most of the cooks (14) adopted a "quick details" mode of looking at the detailed instructions. For most of the instructions, they looked at the detailed instruction on the pop up for less than 10 seconds. Even when the pop up was visible for longer periods of time it was less time than the task took to perform. This suggests the overview, the context of the task, was more important to the cook than the detailed instruction of the current step.

Despite this difference in how cooks interacted with the recipe instructions, there was no difference in the count of problems or errors compared with preparing the recipes in the other Recipe Presentations with one exception, the Salad Recipe. The final step of the Salad Recipe in the Control Recipe Presentation confused cooks because it provides the instructions for two components of the recipe (gremolata and dressing) but does not distinguish them linguistically.

> For the gremolata, use a vegetable peeler to pare thin strips of rind from the lemon. Carefully remove as much white pith as possible (this is bitter). Finely chop the lemon rind and toss with the garlic and parsley. Season and set aside. *Squeeze the juice from the lemon and whizz in a food processor with the peeled tomato and pesto for 10-15 seconds. Pour over the potato mixture and toss through.* Scatter over the gremolata to serve.

The paragraph starts and ends with instructions for gremolata. In between, and highlighted above in italics, is the instruction for making the dressing. Cooks had problems understanding these instructions. As a result of the problems they made errors in making either the gremolata, the dressing or both; three cooks made a dressing that combined all the ingredients mentioned in the step, three more omitted the tomato from the dressing, added lemon juice to the gremolata etc. Cook 14 illustrated the confusion with the recipe steps in the Segmented-with-pictures Recipe Presentation:

> "It says to pour over the potato mixture and now it says to scatter over the … hmm, I'm not sure if I put some things together too early or what …right, what peeled tomato? Is there a peeled tomato? [scans the

ingredient list]…oh one ripe tomato peeled and seeded, oh, I just assumed it was these things, what else is there with the food processing? Already but never mind, OK, I guess it's done, minus one tomato"

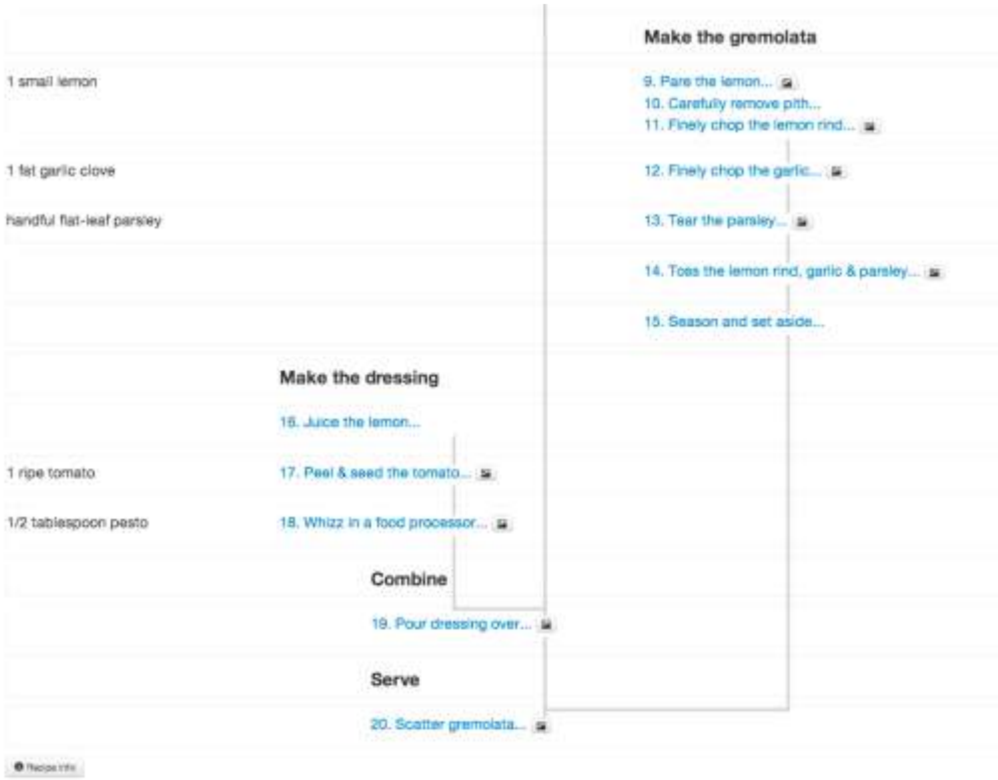

Figure 88: Final step of the Salad Recipe in the Overview Recipe Presentation

When the step was presented in the Overview Recipe Presentation the dependencies between the short steps were drawn out, the ingredients for each step were associated with the individual steps. Seven cooks had problems with recipe content (the recipe text did not explain how to peel a tomato or pare the lemon) but no cooks made errors making the gremolata and dressing.

The design of the Overview Recipe Presentation was inspired by flow chart form of recipes, such as Figure 53 created by Chavelli Tsui. The flow chart format of recipes is also apparent in the recipe graphs generated from semantic analysis of recipe texts (for example Wang et al., 2008). In their work, Wang et al, describe a process of analysing textual recipes to identify the underlying structure of the recipe procedure. From this they draw recipe graphs showing dependencies between ingredients and tasks in the recipe procedure. When this analysis has been performed over a library of recipes, the library can be searched for recipes with similar procedure patterns.

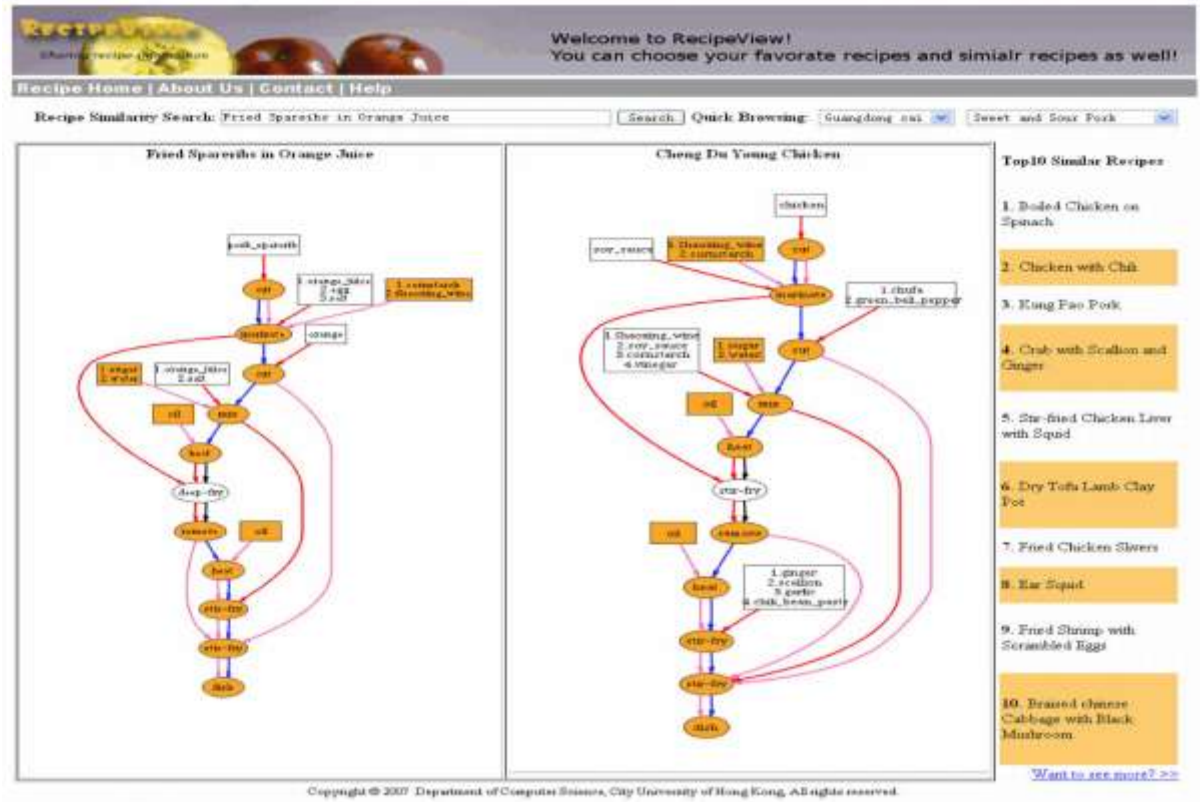

Figure 89: Recipe search using recipe graphs

Figure 89 shows a screen shot from the recipe search prototype by Wang et al (2008). Although the motivation for their work was to improve search facilities of recipes, the screen shot illustrates the potential for using a similar algorithm for generating an Overview Recipe Presentation for use by cooks while cooking.

The findings from this study suggest that cooks found recipes in the Overview Recipe Presentation better organised and a better support for the way they approach the tasks within the recipe, for example preparing ingredients as they go and looking for tasks to perform in parallel. The cooks had fewer problems with the Salad Recipe because they could see the tasks and sub-goals of the final step.

7.4.4 Limitations of the study

7.4.4.1 Cooks' skills and recipe difficulty

Results from this study cannot be used to support claims that alternative Recipe Presentations help cooks of particular skills levels with difficult recipes. Considering the validity flaws in measuring cooking skills by questionnaire (Short, 2002), I drew questions about skills from earlier researchers, for example Mennicken et al. (2010), and from anthropologists performing research into food and cooking habits (Hubert, 2004) but recognise this still provides only a limited approximation.

Earlier researchers, for example, Mennicken et al. (2010) set a design goal to help "hobby chefs when preparing unfamiliar recipes and to increase their confidence" (p3404) and observed that their system "seems to lower the perceived difficulty [of recipes]" (p3407). They took a single measure of cooks' skills, on a scale of 1-5 and provided no details on how they rated recipe difficulty so it is not clear how they drew the conclusions they did.

In this study the recipe rated most difficult was the Salad recipe (M=3.42, SD=1.21). I found the more frequently a person cooked and the higher they rated their skills, the lower they rated the difficulty of recipes but there was no relation found between cooks' ratings of recipe difficulty and their confidence to make the recipe. Further, the cooks' confidence to prepare the recipe, measured before and after each cooking session did not correlate with their self-rating of skills or frequency of cooking. The findings show the relationship between skills and confidence to make a recipe is not clear, and lacking an objective measure of recipe difficulty it is not possible for research such as this study to make claims as proposed by earlier researchers.

7.4.4.2 Reading the instructions

Without eye-tracking tools it was not possible to measure precisely the time that cooks read the separate recipe instructions. As a consequence a detailed examination of the attention paid to different instructions or parts of the recipe and its relation to problems experienced or errors was not possible. Previous research investigating the effect of different instruction designs has required users to hold down a key on a keyboard, or a mouse button (Karreman et al., 2004). Imposing this on cooks would reduce the ecological validity of the study and obscure behaviour essential to understanding the context in which recipe support systems must deliver. The potential of eye-tracking tools to assist this may be worth investigating for future research.

7.4.4.3 Sensitivity of measures

In this study, as in the previous, the cooks' post-cooking ratings showed an effect of Recipe Presentation that generalised over recipes, while other measures such as time to complete, count of problems and errors did not. The reasons lie in part with the sensitivity of measures due to the experimental design and difficulty matching recipes and cooks. For example, a reflection on why time to complete showed no effect of Recipe Presentation confirms the findings of the previous study; cooks vary more in the time they take to prepare recipes than they do due to systematic variations between Recipe Presentation so any effect is lost in the noise. Similarly cooks varied in the count of problems and errors they experienced with different recipes.

As cooks show such variation, the most appropriate experimental design is repeated measures, however the difficulty of matching recipes for the materials of a repeated measures design limits the ability to show if and how effects of Recipe Presentation generalise across recipes. In this study, cooks rated the difficulty of recipes but no correlation was found between the difficulty of recipes and the count of problems and errors. A qualitative analysis of the problems and feedback from cooks suggested that cooks' knowledge of ingredients and techniques may affect the count and type of problems, for example, few cooks had previously heard of gremolata, they had problems understanding the instructions and made errors making it. This suggests that future researchers, who wish to make use of quantitative measures to investigate how Recipe Presentations generalise across recipes should consider matching recipes, not only on quantitative ratings of difficulty but also consider the qualitative matches on familiarity of ingredients, terminology, task patterns and difficulty.

7.4.4.4 Order effects

In the previous study, the final recipe was rated the lowest and took the longest to complete. Because of the experimental design, it was not possible to rule out if this was related to order effects such as fatigue. As the experimental design of this study followed that of the previous, it would be reasonable to expect similar issues with the final recipe in this study. The Linguini Recipe, however, was the fastest to complete and cooks had fewer problems with the recipe and these findings generalised over the Recipe Presentations. This suggests the different times and ratings of the Dip Recipe in the previous study and the Linguini Recipe in this study were not related to the order of presentation but to the particular recipe and the cooks' experience with it.

7.4.4.5 Variation in text size and legibility

The text size of recipe instructions in the Overview Recipe Presentation was smaller than that used in the Control and Segmented with Pictures presentations. In this study no problems with legibility were noted by cooks or observed of the cooks' interactions with the recipe, however this may be due to the mean age of participants (21 years). For improved experimental control and to investigate how well results generalise to a wider population, including people with visual impairments, future studies should ensure consistent text size and legibility between Recipe Presentations.

7.4.5 Conclusions and implications for design

This study investigated the effect of adding pictures to segmented recipe steps. It confirmed findings from the previous study that cooks do not read or follow recipe instructions in a linear and sequential manner. Segmenting recipe steps is the simplest way to transform the traditional recipe form to a form for presention on a small screen mobile device. However, the findings show this is not an appropriate design because it does not match the way that cooks read and use recipe instructions. Adding pictures was popular with the cooks but did not reduce the number of problems or errors made.

This study also investigated the effect of presenting an overview representation of the recipe structure with detailed recipe instructions available as required. This presentation was given the highest rating for well organised instructions and cooks had fewer problems with the recipe content. The findings suggest that future research should further investigate the benefits of presenting an Overview of recipe instructions for cooks and investigate how algorithms from semantic analysis could be incorporated into interactive recipe systems.

Chapter 8 Conclusions

8.1 Summary of results

8.1.1 Focus groups and food diaries with older adults

The studies in Chapters 3 and 4 investigated the cooking and other food-related activities of older adults and whether the assumptions of the earlier human-food interaction literature applied to older adults. Food related systems in the earlier literature, for example *EdibleEarth* (Bohner et al., 2009) and *CounterActive* (Ju et al., 2001), were designed with younger people in mind, considering them to be novices in planning, shopping and cooking food. The functionality they offered, for example helping cooks find local seasonal ingredients and encouraging people to cook, could be beneficial to the wider population but few researchers have explored this.

The focus group study described in Chapter 3 investigated the food related behaviour of 15 older adults through discussion. The food and shopping diary described in Chapter 4 indirectly observed food related behaviour in another 15 older adults over a 7-day period to provide more detailed results and triangulate the results from the focus group study. The findings from these studies showed that assumptions behind meal planning systems, shopping systems and cooking support systems did not apply to these groups of older adults.

In earlier meal planning systems, (e.g. Aberg, 2009), cooks were assumed to plan the details of meals for 3 or 4 days in advance. The findings showed that few cooks planned meals in advance, and where they did it was only the main meal of the day and not in great detail.

In earlier shopping support systems, (e.g.Bohner et al., 2009), it was assumed that the majority of shopping was performed in supermarkets or other similar stores where all items were associated with a database that included provenance, nutrition and further data and that cooks needed nudging to choose local and more healthful foods. The findings of this thesis showed that, although most cooks do shop at supermarkets, a large amount of shopping is done at small stores and markets where such data is not readily available. They also found that, for these cooks at least, there was no need for additional information on how to choose local or healthy foods.

Finally, in discussing cooking, the findings of these studies show that cooks seldom use recipes or cook with the precision associated with recipes. As a consequence, systems that presented interactive recipes and are focused on accurate reproduction of recipes or measurements of ingredients, (e.g. Hamada et al., 2005; Mennicken et al., 2010) would not support the needs of these older adults.

8.1.2 Interactive recipes: investigating effect of recipe formats

The studies described in Chapters 6 and 7 investigated the effect of different interactive recipe designs with cooks in the kitchen. In each study, 24 cooks prepared three recipes, one in each of three recipe presentations including a control.

In Chapter 6 two Recipe Presentations were investigated with design elements that were based on guidelines and findings of instruction design research (e.g. Chandler & Sweller, 1991; Ganier, 2004) and that were observed in the design of earlier interactive recipe systems such as *PersonalChef* and *Panavi* (Uriu et al., 2012) but not evaluated in these earlier studies.

In the first Recipe Presentation (Segmented), recipe steps were segmented and presented in short steps. For instructions designed for initial use, shorter steps have been found to reduce the overall time to complete a task because they reduce the search time between instructions (Duggan & Payne, 2001). In the second Recipe Presentation (Integrated) the ingredient quantities and preparation instructions were integrated into the recipe instructions. In traditional recipe format, the information is split, forcing the cook to switch attention between different parts of the recipe and increasing cognitive load (Chandler & Sweller, 1991; Paas et al., 2003).

Comparing the Control and Segmented Recipe Presentation, cooks found the long paragraph style steps in the Control Recipe Presentation difficult to use. The short steps in the Segmented Recipe Presentation did not solve the cooks' problems but they made visible behaviour not previously documented – cooks do not follow recipe instructions or perform tasks in a sequential step-by-step manner. They were observed to look ahead in the recipe to find tasks to perform in parallel with the current task, to find information to help interpret the current task and to help plan tasks.

Recipes in the Integrated Recipe Presentation were rated clearer to read and easier to use than recipes in the control presentation. Cooks did not measure and prepare all their ingredients, known as *mise-en-place*, before starting tasks in the method instructions. In traditionally formatted recipes the ingredient quantity and preparation instructions are written in the ingredient list forcing those who do not mise-en-place to switch attention between method instructions and ingredient list. Integrating this information into the recipe step supports the cooks' preferred behaviour pattern of measuring and preparing ingredients as they go.

In Chapter 7 two further Recipe Presentations were investigated. The first (Segmented-with-pictures), in which instructions were illustrated with pictures of the goal state, was again drawn from guidelines from instruction design (Ganier, 2004) and also observed in the design of earlier interactive recipe systems such as *PersonalChef* (Mennicken et al., 2010) but not evaluated against a control recipe without pictures. The second Recipe Presentation (Overview) was designed as a potential solution to the observed behaviours of cooks in the previous study who performed tasks in parallel and looked ahead in the recipe to trace the narrative of ingredients. The visual design of the Overview Recipe Presentation was inspired by examples from graphic designers and task dependency graphs.

Cooks liked the pictures. They used them to understand the goal of a task as they started or worked on a task and to confirm they had reached the goal at the end of the task but the pictures did not reduce the number of problems or errors performed overall. The results suggest that pictures may be more useful for some recipes than others. Cooks rated recipes in the Overview Recipe Presentation as better organised, well written and easier to understand compared with the control recipe and results suggested there may be fewer problems associated with preparing recipes in the Overview Recipe Presentation. The majority of cooks viewed the detailed recipe steps for very short periods of time suggesting that clear structure was more important than detailed information in following the recipe.

8.2 Contributions of this thesis

8.2.1 Older adults do not need technical support for food related activities

The first contribution of this thesis is to show that older adults have little need for technological support for their cooking and other food-related activities. Although the cooking skills and experience of older adults varies widely the findings of this thesis showed they planned meals, shopped and cooked according to their needs and their means. It was clear that each area of food related behaviour is complex and this suggests future research is needed to understand how people perform food related tasks.

8.2.2 Assumptions of food related systems do not generalise to older adults

The second contribution of this thesis is to show that the assumptions of food related interactive systems do not generalise to older adults. Although food and the skills for the activities around food are valuable throughout life most of the earlier interactive systems designed to support food related activities such as meal planning, shopping and cooking are designed to support younger people and young families.

The findings of this thesis shows that meal planning was more flexible and iterative than the design assumptions of earlier systems allowed for; that shopping patterns of cooks was mixed and interrelated with meal planning;

and that cooking was more flexible and cooks had less focus on accuracy than design assumptions of earlier systems allowed for.

8.2.3 Recipe tasks are not undertaken step-by-step

The third contribution of this thesis is to show that, in following a recipe, cooks do not read instructions in a strict sequential step-by-step manner and do not perform the tasks in the strict sequence they are presented in the steps. They read ahead for several reasons including setting plans, interpreting the current step and looking for tasks to perform in parallel. For example, a cook might put kettle on to boil for a step that says "cook the pasta" and read ahead to start performing the next step while it boils thus performing two or more tasks in parallel. This has implications for design. Interactive recipe systems should enable cooks to have multiple, non-contiguous steps active at any one time.

This has not previously been observed and documented. Earlier interactive recipe systems such as *Panavi* (Uriu et al., 2012) and *PersonalChef* (Mennicken et al., 2010) highlighted a single step as active and restricted cooks' progress through the recipe to forwards. As a consequence, if cooks moved ahead in the recipe but still needed to complete a task unfinished from another step they could not move back in the recipe to refresh their memory of the wording.

The findings presented in this thesis show designs of future interactive recipe systems should seek ways to support the needs of cooks to have multiple recipe steps active at once and enable them to move between these, backwards or forwards, through the recipe.

8.2.4 Recipe format, structure and presentation is not neutral

The fourth contribution of this thesis is to show that recipe format is not neutral and must be considered in the design of interactive recipe systems.

In earlier interactive recipe systems such as *PersonalChef* (Mennicken et al., 2010) the recipe instructions were presented in short steps, with one task per step and with the ingredient quantities integrated into the instruction. This contrasts with the traditional format of recipe, as recommended by recipe writers guidelines (e.g. Gibbs Ostmann & Baker, 2001; Jacob, 2010), which splits information across the ingredient list and method instructions and presents method instructions in paragraphs with many tasks per paragraph.

The findings presented in this thesis show that recipe format affects the cooks' experience of using the recipe. Cooks find it difficult to use instructions presented in paragraphs because they lose their place in the paragraph and they rate recipes as clearer and easier to use when the ingredient information is integrated into the instructions.

Neither the structure and format of recipe instructions, or the location of content within it, was discussed in earlier research (e.g. Hamada et al., 2005; Ju et al., 2001; Mennicken et al., 2010). As a consequence it was not possible to distinguish between the effects due to instruction design and those due to factors of unique interaction design in evaluating their systems' success.

8.2.5 Guidelines for procedural instructions used to inform design of recipe instructions

The fifth contribution of this thesis was in drawing on guidelines laid out in instruction design research to inform the design of recipe instructions for interactive recipe systems.

Although an extensive body of research in psychology has addressed design of procedural instructions (e.g. Ganier, 2004) and other researchers within HCI have focused on designing instructions for interactive systems (e.g. Fothergill et al., 2012), no attempt to draw on this knowledge has been made in the design of instructions in earlier interactive recipe systems. Indeed the design of earlier interactive recipe systems was essentially ad-hoc and provided no basis on which to build future research.

The findings reported in this thesis confirm that firstly, integrating information from split sources (in this case the ingredient list) (see Paas et al., 2003) into method instructions makes recipes easier to use and secondly, suggest that organising instructions into meaningful chunks and identifying sub-goals (see Ganier, 2004; Steehouder et al., 2000) as in the overview recipe better supports cooks in their activities.

8.2.6 Describing the problems and errors typically experienced by cooks

The sixth contribution of this thesis is to identify and highlight problems that cooks typically experience with recipes and the errors they perform in following them. In earlier studies, the problems that systems claimed to resolve were not supported by empirical evidence and therefore it was not possible to demonstrate the effectiveness of the system in resolving these problems.

The findings of this thesis show that cooks' problems emanate from several sources including the recipe content, from cooks' knowledge or lack of knowledge about ingredients and techniques and their implementation of the tasks in the recipe. Taking these findings, future researchers can develop content and design for interaction recipe systems directed at different sources of problems and measure their success in resolving them.

8.2.7 Describe a methodology for evaluating future interactive recipe systems

The seventh contribution of this thesis is to demonstrate a methodology for evaluating future interactive recipe systems. Few of the earlier interactive recipe systems were evaluated, and of those that were, none were evaluated with measures appropriate for the stated goals of the system or evaluated against cooks using a control. As a consequence it was not possible for designers of these earlier systems to infer a causal relationship between their system design and the cooks' successful preparation of a recipe.

The studies described in Chapters 6 and 7 evaluated different Recipe Presentations in a controlled experimental design to enable causal inferences to be made. Three recipes were prepared in each Recipe Presentation to ensure results were not linked to a specific recipe and were generalizable. Measures taken in these studies include those designed to capture the effect of different Recipe Presentations on the efficiency of reading or preparing the recipes, of confidence and ease of using the recipes and of the number of problems and errors.

Considering the findings presented in this thesis, the measures were not all equally successful in finding an effect of different Recipe Presentations. The methodology used does, however, provide a basis on which future research can build.

8.3 Limitations and Reflections

The findings of this thesis are subject to the limitations of the participant selection, methodologies, measures and the analysis applied to them. In the first two studies, the older adult participants were self selected people who were interested in food and cooking and the findings therefore may not be generalizable to the wider population of older adults. Considering the methodologies, focus groups provided an opportunity to discuss food-related behaviours with a large number of participants. However, the participants' contributions were subject to demand characteristics, for example in one focus group the participants argued about the role of ready made meals in feeding a family and in another they argued about using cream or crème fraiche in cooking. It was clear to me that food and cooking had moral aspects to these participants that influenced their public utterances.

The diary study and post-diary interview methodology of the following study addressed these concerns to a degree but was subject to its own limitations. The diary generated a large amount of data of differing degrees of detail that proved challenging to analyse effectively. On reflection a more structured diary, designed to capture more quantitative data, supplemented with interview data may have generated more useful results more efficiently.

Studies three and four investigated how cooks interact with recipe instructions in the controlled environment of the kitchen in the Homelab. The findings of these studies are limited firstly by the participants who were students with a range of skills and experience. As there is no formal measure of either cooking skills or experience, it was not possible to distinguish them into levels of skill. This may have thrown light onto the variability of the results, for example the time taken to complete each recipe and the different strategies of task planning and enacting.

In order to ensure comparable results, the cooking sessions took part in the the kitchen in the Homelab to ensure cooks had access to the same equipment and ingredients. However the unfamiliar surroundings and the experience of being observed may have obscured some of the normal cooking routines of cooks. Further, the lengthy nature of the tasks and the repeated measures design meant that the session time was lengthy, about 3 hours, and so cooks may have suffered fatigue. The order of Recipe Presentations was balanced but the order of Recipes remained the same for each participant so if there were fatigue effects this would have affected the final recipe in each study. On reflection, effects of fatigue could have been reduced by inviting cooks to participate over three separate sessions, although this would have led to a loss of participants between sessions.

It was noted in Chapters 6 and 7 that several quantitative measures, including time to complete and count of problems and errors, failed to show a difference between Recipe Presentations and failed to show if they generalised across recipes. While these measures are of import to researchers in order to distinguish “better” interface designs, the reason they failed to show an effect may be in part because the measures do not matter to the cooks. For example, although cooks may prefer to choose a quicker recipe, they did not rate any lower, the recipes that took longer to prepare. Efficiency, the time to complete and therefore their speed of preparation may not be of importance to cooks. Similarly, the concept of accuracy and thus reduction of errors may not be important to cooks; in both studies, cooks were seen to make deliberate errors and in some cases argued that the recipe was wrong and they were right. This suggests that, for these cooks, counting errors is not an appropriate measure of an improved user experience of the system. It may be more appropriate and more aligned with UCD to measure user experience and satisfaction to evaluate the success of different Recipe Presentations and how the effects generalise over recipes.

While the research focused on cooks' interactions with recipes, this was at the abstract level of their user journeys through the recipe instructions rather than the physical interactions necessary to take each step of the journey. For studies in this thesis the physical interaction was based on taps to the screen and this exposed user problems due to the situation of use; cooks' hands become mucky with ingredient mixtures that they have to clean off before tapping the iPad screen and they got frustrated when they had to do this often while preparing a recipe with short instructions requiring many taps to move through them.

One means of addressing the mucky-hand problem may be found in using a stylus to tap the screen. Having seen the mucky-hand problems experience in the study in Chapter 6 this was considered for the study in Chapter 7. However, it was not implemented because of the frustrations of using a stylus noted by Terrenghi et al. (2007) in their Living Cookbook studies and because the number of mucky-hand problems were low in relation to the problems that were the focus of this thesis, i.e. of the content and presentation of recipe instructions.

The development and growing availability of non-touch ways of interacting with tablet devices, such as gesture and voice control, offer routes for potential future research. Gesture control of tablet devices is becoming available with recent implementations, such as air gestures and head gestures in iOS7[25] [26].

[25] https://developer.apple.com/ios7/

Gesture control, however, requires users to learn a new vocabulary (Bailly, Müller and Lecolinet, 2012) that potentially introduces a new level of user problem. Voice control of recipes systems, as proposed in the eyeCOOK (Shell et al., 2003) and tutoring system (Martins et al., 2008), may become possible in mainstream devices in the near future. However, neither of the earlier research teams evaluated the user experience of voice control in the kitchen and what problems might be encountered due to background noise from the kitchen environment. Future research should investigate if these new interaction modes may improve user experience by reducing the mucky-hand problem without introducing new problems.

8.4 Future research

The research in this thesis has documented for the first time how cooks interact with recipe instructions in different Recipe Presentations and evaluated the effect of design elements not previously evaluated. However, the research revealed that more specific studies are needed to clarify the effect of design elements and to refine the recommendations for future designs of interactive recipe systems.

8.4.1 Improving the effectiveness of recipe pictures

Previous research (Mayer, 2001) has suggested that procedural instructions are more effective when associated with illustrations because pictures provide a more direct view of the task being described. In my research I found that cooks looked at pictures for different reasons, sometimes to gain insight into an appropriate technique and sometimes to discover the goal state of the mixture they were working towards. It would be useful then, to investigate whether the effectiveness of content type varies by the type of recipe or recipe instruction or by the skills and experience of the cook.

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[26] http://www.nanocritical.com/nanogest/

8.4.2 Relocating the research to the home

My research was performed in a lab kitchen in order to ensure each cook had access to the same equipment and ingredients and to enable efficient set up for recording their activities. It could be argued that the unfamiliar kitchen and the experience of being observed while cooking may have influenced the cooks' behaviours. A counter to this would be that the number of deliberate errors showed that cooks were confident to impose their preferred way of working over the recipe instructions despite being told at the start of the study they should "follow the recipe instructions".

In the past, little research has been performed observing cooks in their home kitchens, in part due to the complex nature of setting up recording equipment to capture only the cooking activity (see Wagner et al., 2011). Recent technological innovations may now enable remote evaluation of cooks using iPads or similar technology in the home[27]. It would be useful for future research to investigate if such remote evaluation tools would capture more ecologically valid results.

8.4.3 Transforming traditional recipes automatically

There are millions of textual recipes currently available on the web in repositories including recipe.com and epicurious.com. These recipes are commonly held in the traditional two part textual form. In order to make the Overview Recipe Presentation available for these recipes, a method to transform textual recipes into integrated and Overview Recipe Presentation is required. Researchers in the field of semantics have developed techniques to identify structures and dependencies within recipe texts (Dufour-Lussier et al.,

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[27] http://whatusersdo.com/user-experience-testing/rapid-online-mobile-user-testing.php

2010; e.g. Wang, Li, Li, & Meng, 2006; Xie, Yu, & Li, 2010). Future research could investigate how these recipe graphs can be adapted to develop interactive recipe systems that automatically transform recipe texts.

8.4.4 Adding video clips to recipes

Video clips were used as an integral part of earlier interactive recipes system to make them fun to use (e.g. Ju et al., 2001), to make them more personal and engaging (e.g. Terrenghi et al., 2007) and to show how techniques should be performed (e.g. Uriu et al., 2012). Video clips have become common in commercial recipe applications from established chefs (e.g. Jamie's Recipes[28]) and food bloggers (e.g. Appetites[29]). It is not clear from the earlier research, however, how best to implement video clips to help cooks. For example, would it be more useful to show short video clips of individual tasks that a cook can watch while stirring the pot or to show longer video clips that might require the cook to put all preparation and cooking on hold while they watch? Future research could investigate what granularity of tasks on video clips and frequency of switching from preparation to viewing video best supports cooks' activities.

8.5 Conclusion

The aims of this thesis were to investigate the food related activities of older adults, to investigate if design assumptions of existing food related systems generalised to older adults and to investigate how cooks interact with recipe instructions.

Considering the first two aims of the thesis the findings showed the food

[28] http://www.jamieoliver.com/apps/

[29] http://appetitesapp.com/

related activities of older adults were routinized and flexible and they had little need for technological support. Although older adults varied in skills and experience, they were confident in their meal planning, shopping and cooking activities. The design assumptions of earlier food related systems did not generalise to older adults. For example, although they planned meals for several days in advance, they did not plan them in high detail and they were happy to adapt their plan according to the situation on the day.

The next aim of this thesis was to investigate how cooks interact with recipe instructions to inform the design of future interactive recipe systems because no previous research has explored this area. In pursuit of the main aim, guidelines and findings from instruction design research were applied to recipes, the strategies and behaviours of cooks were described and the effect of different Recipe Presentations was evaluated against a control.

Considering the guidelines from instruction design research, when the sole transformation was to shorter recipe steps there was no benefit to the cook but when information from ingredients list was integrated into the recipe steps cooks found the recipes easier to use than control. Cooks preferred recipe steps that were illustrated although there was little evidence they improved the rate of problems or errors.

Analysis of the reading patterns of cooks and observations of how they performed tasks showed that cooks did not mise-en-place their ingredients and did perform tasks from several steps in parallel. Evaluations of the different Recipe Presentations showed that, firstly integrated instructions were easier to use than recipes with split information and secondly that recipes presented in a flowchart to enable cooks to get an overview in a glance better supported how cooks work.

Lacking much previous research in this specific field to build on, the research process unfolded over time and built on itself as my understanding of instructions and cooks' behaviours developed. The research took place in a lab kitchen which limits the generalizability of the results and the field will benefit from future research performed in cooks' home kitchens. There were technical challenges in recording the cooks activities and as the majority of the analysis was qualitative, the results were necessarily a little subjective.

Finally, to conclude this thesis, the implications of the findings herein are that cooks' interaction with recipe instructions is complex but patterned. This has implications for the design of interactive recipe systems. They can no longer be designed assuming sequential step-by-step use of the recipe instructions. Cooks work in parallel and in order to support their work, interactive recipe systems must reflect this. Further, in demonstrating a methodology for evaluating different Recipe Presentations, future researchers can build on this to demonstrate the effectiveness of new designs.

Appendix 1 Focus groups materials

A. Recruitment leaflet

Research into cooking habits of older people

At the Department of Computer Science, University of York

THE UNIVERSITY of York

What the research is for

My research explores how people use technology in their kitchens. I'm interested in the gadgets, appliances and utensils you use to cook, and what inspires your cooking – do you share recipes with friends, use recipe books or cook whatever is in the fridge?

The goal of my research, which will form my PhD, is to develop technology that will help older adults enjoy cooking more and stay independent longer.

When does it happen?

Research started in March 2010 and continues through the year.

How you can take part?

If you are over 60 and living independently and would like to take part then please contact me.

You can take part in a focus group of about 90 minutes at the University of York. You will be asked to bring along two utensils or gadgets from your kitchen that we can talk about over tea and home made cakes.

You may also be interested to take part in a food diary study. I will ask you to fill in a diary for a week with all your meals and shopping trips for the week.. At the end of the week I will come to collect the diary, and interview you in your kitchen.

What happens with your information?

The focus group and the food diary study interviews will be recorded and later transcribed. But any information identifying individuals will be omitted or disguised. Thus your information will be completely anonymous and confidential.

The next step

If you would like to take part, or find out more about the research, then please call or email me – my contact details are on the other side

Contact details

Lucy Buykx

Department of Computer Science

University of York

Heslington

YO10 5DD

Tel : **01904 433 376**

Email : **buykx@cs.york.ac.uk**

Research supervised by **Helen Petrie**, Professor of Human Computer Interaction Research Group

Tel : **01904 434336**

Email : **petrie@cs.york.ac.uk**

B. Informed consent

Research project : Cooking habits of older people

Research activity : focus group about cooking habits, utensils and gadgets used for cooking

Date : 29 April 2010

Researcher : Lucy Buykx

Supervisor : Helen Petrie

Please read the following statements and sign at the bottom to indicate your consent to participate.

1. The purpose and procedure of the focus group have been explained to me.
2. I acknowledge that
    a. Any utensils I have brought along will be photographed
    b. The focus group discussion will be recorded and transcribed
    c. Any identifying information will be omitted or disguised in the transcripts so my contribution will remain anonymous and confidential
3. I further acknowledge that
    a. My participation is voluntary
    b. The focus group will take about 90 minutes of my time
    c. I have been informed that I may withdraw at any time and if I do then my contribution will be removed from the research analysis
4. I consent to participate in the focus group

Participant name : ____

Signature :

____

Date : _____________________________________

C. Participant questionnaire

About you and your cooking habits

A short questionnaire about you and your cooking habits. Please tick the answers most appropriate to you and add any extra comments in the boxes provided.

Household composition

Do you	Your age	Are you
• Live alone • Yourself and spouse/partner • Yourself and other adults/children	• Under 50 • 50-59 • 60-69 • 70-79 • 80+	• Male • Female
Comments:		

Culinary history (how, when, where you learned to cook)

When did you learn to cook?	What do you use / have you used to expand your cooking knowledge and try something new?
• As child at home from my mother/father • As pupil in cookery lessons at school • As a young adult fending for myself • When I started a family • Later in life (please say when in comments box)	• Cookery classes • Cookery books • TV cookery shows • Swapping recipes and techniques with friends • Articles and recipes in magazines • “how to” videos on the internet • articles and recipes from websites
Comments:	

Appendix

Dietary restrictions

Do you or anyone you cook for have dietary restrictions or need a special diet? • Vegetarian/vegan • Gluten free • Allergies (dairy/nuts etc) • Halal • Kosher	Do you or anyone you cook for need to monitor their diet? • Weight loss • Diabetes • Cholesterol
Comments:	

Shopping (frequency, transport, local store/supermarket, shopping list)

Do you do the shopping for the household? If you don't then please note who does in the comment box and answer these questions as they would

How often do you shop for food? • Daily (5+ times a week) • Several (2-4) times a week • Once a week • 2-3 times a month • less often	Where do you go shopping? • Supermarket • Small stores (Butchers, bakers, green grocers) • Speciality stores (whole/healthfood) • Markets • Local suppliers (e.g. direct from farmers)
How do you plan what to buy? • Plan meals and make shopping list • From memory because you buy much the same each week • Buy what is on offer or appeals in the store	
Comments :	

Appendix

Meals you don't cook yourself

How often do you…	Seldom / never	1-2 times a week	3-5 times a week	Most days
How often do you eat out? (or with friends or family and you don't need to cook!)				
How often to you have prepared meals delivered, ready for you to heat and eat or already hot and ready to eat?				
How often does someone else cook for you at home?				
Comments :				

Utensils for focus groups

What utensils have you brought along ?

Most liked and used	Not liked or difficult to use

Appendix 2 Food and shopping diary materials

A. Informed consent for participants

Research project : Cooking and shopping habits

Research activity : Food and shopping diary, photo log and interview

Date : July 2010 **Researcher** : Lucy Buykx **Supervisor** : Helen Petrie

Phone : 01904 433 376 **Email :** buykx@cs.york.ac.uk / petrie@cs.york.ac.uk

Please read the following statements that describe what to expect if you agree to participate in this research. If you agree then please sign at the bottom and return the form in the enclosed return envelope.

5. I will receive a participant's pack in the post that will contain;
    a. 7 day Food and shopping diary
    b. Disposable camera (if requested, otherwise I will use my own digital camera and email the photos)
    c. Return stamped addressed envelope
6. I will write in the Food and shopping diary every day for 7 days
    a. On each day I write information in the diary about the food I have purchased or had delivered, what I prepared to eat and what I ate
    b. On 3 of the 7 days, I will use the enclosed camera to take pictures of the preparation of my main meal
7. At the end of 7 days I will place the completed food and shopping diary and the camera into the return envelope and post it back
8. I agree to take part in an interview about my food and shopping diary, that will be arranged within 1 week of completion of the diary. The interview will take place according to my preferences, either
    a. In my home
    b. At the Department of Computer Science
    c. Or on the phone
9. I acknowledge that
    a. My participation is voluntary
    b. I may withdraw at any time and if I do then my contribution will be removed from the research analysis
    c. Any identifying information in my food and shopping diary and photos will be omitted or disguised so my contribution will remain anonymous and confidential

Appendix

I understand what I am expected to do and I consent to participate in the food and shopping diary study

Participant name : ____

Signature :

____

Date : _____________________________________

B. 7 day food and shopping diary

Title page

Part of a research study performed by

Lucy Buykx at

Department of Computer Science

University of York

Heslington

York

YO10 5DD

Tel : 01904 433 376

Email : buykx@cs.york.ac.uk

Supervised by

Professor Helen Petrie

Email : petrie@cs.york.ac.uk

Participant : 20

Appendix

Thank you!

Thank you for agreeing to take part in my research about the cooking and eating habits of older people. I will use the information learned from your participation to help develop technology that will help older people enjoy cooking more and stay independent longer.

Instructions for use

Please write in this diary for 7 days. Please answer questions about what you ate each day, about the preparation of your main meal of the day and your shopping trips. If you use paper shopping lists then please attach them to the shopping pages.

On days 2,3 and 4, please take pictures of the preparation of your main meal with the single use camera supplied or your digital camera. Please also take some pictures of where you prepare food in the kitchen.

Please write the date you started (day 1)____

Taking pictures (days 2,3,4)

Please take pictures of the preparation steps of your main meal, including pictures of the utensils and appliances you use and the final prepared meal before you eat it. Don't worry if you forget to take pictures one day, or are eating out or someone else is cooking for you, please just take pictures the next day instead. Don't worry if you run out of film.

If you have a digital camera, and would prefer to take pictures with your camera and email them then please do!

When you are finished

Please put this food diary, any shopping lists and the camera [if supplied] into the supplied envelope and send it back to Lucy Buykx.

Day ______________________

What did you eat today ?

Please describe what you ate in the first column, then tick if you prepared it yourself and say where you ate it.

	Please describe what you ate	Prepared by me	Home or out?
Breakfast			
Lunch			
Evening meal			
Snacks			
Snacks			

If you prepared and ate your main meal at home then please turn over and complete questions 1-6 about your meal. If someone else made it for you then skip questions 1-6.

If you went shopping today, please turn over and complete questions 7-10.

Your main meal of the day – Breakfast / Lunch / Evening meal (please circle)

1. When did you plan what to make and eat? (please tick)

☐ Just before I started making it
☐ Earlier in the day
☐ Yesterday / a few days ago

2. What did you make ?

3. How did you make it?

4. Please list the main ingredients for the meal (and tick where you got them from)

If you used a pre-prepared ingredient or dish e.g. a jar of pasta sauce or a lasagna ready-meal then please list this as an ingredient.

Ingredient	Shop-bought for this meal	Shop – bought for this week	Store cup-board / fridge staples	Left overs	Garden or	Other (please describe)

5. Do you cook similar meals

- ☐ Often
- ☐ Regularly
- ☐ Sometimes
- ☐ Never tried it before?

e.g. If your meal is spaghetti with tomato sauce, do you often make similar meals such as macaroni cheese, or pasta shells with vegetable sauce?

6. Did you use a recipe or recipes for the meal ? If so

a. Where was/were recipe(s) from ?

(please tick)

- ☐ Cookbook (please write title below)
- ☐ Magazine
- ☐ Friend or family
- ☐ Memory
- ☐ Other (please describe)

b. Have you made recipe(s) before?

(please tick)

- ☐ Many times
- ☐ A few times / not recently
- ☐ My first use of this recipe

Did you go shopping today – Yes / No

7. Where did you shop ? (please tick all that apply)

- ☐ Large supermarket
- ☐ Medium supermarket
- ☐ Small/local supermarket
- ☐ Online supermarket
- ☐ Butcher
- ☐ Bakery
- ☐ Green grocers
- ☐ Fish mongers
- ☐ Health food store
- ☐ Market stall/farmers market
- ☐ Mobile store (e.g. fish van/milkman)
- ☐ Veg box delivery
-

What is/are the shop(s) called?____

8. How did you get to and from the shops?

- ☐ Car
- ☐ Taxi
- ☐ Bus
- ☐ Walking
- ☐ Cycling
- ☐ Other/Internet

How far did you have to travel (please give a rough guess)

____________________miles

9. Did you use a shopping list?

- ☐ written (paper,PDA,etc)
- ☐ in memory
- ☐ Part written, part memory
- ☐ No

If possible, can you attach your shopping list to the next blank page

10. What did you buy ?

Please list all the **food items** you bought (ignore non-food items such as washing up liquid, tissues etc), and tick all the columns that apply

Food item	Regular purchase (store cupboard)	For specific meal(s)	On shopping list	Spontaneous purchase	Packaged and has a bar code

Please attach your shopping list here

Appendix 3 Materials for RECIPE1 study

A. Participant profile for RECIPE1 study

ABOUT YOUR COOKING

How often do you cook?

- ☐ Every day
- ☐ Most days
- ☐ 3-4 days a week
- ☐ 1-2 days a week
- ☐ Less often

How/when did you learn to cook?

- ☐ At school
- ☐ At home with parents
- ☐ Taught myself
- ☐ Adult cooking course
- ☐ I just dabble

How often do you use a recipe for a dish or meal?

- ☐ Most days
- ☐ 1-3 days a week
- ☐ 2-3 days a fortnight
- ☐ 2-3 times a month
- ☐ once a month
- ☐ special occasions only (which ones ?
  ______________________________________)
- ☐ Less often

When you use recipes where do they come from? (tick all that apply)

- ☐ Cookbook
- ☐ Supermarket recipe cards
- ☐ Magazines
- ☐ Recipes from friends or family

☐ Websites

Comment

About you

Age : Sex : Male / Female

Do you have any children? YES / NO If **YES**, what ages? ___________________

About where you live

Do you live on campus? YES / NO

- If **YES** : what college? __________________________
- If **NO** : Do you live

☐ Sharing with other students

☐ With your parents and family

☐ With spouse/partner/children

☐ Other______________________________

Before you came to University of York were you

☐ Living with your parents and family

☐ Living alone

☐ Living with friends

☐ Living with spouse/partner/children

☐ Other ________________________________

What degree are you doing? ______________________________

What year are you in ? ______________________________________

B. Post cooking questionnaire for RECIPE1 study

Recipe questions

1. Were the instructions clear? (rate 1-5 and add optional comment)
2. Were the instructions easy to follow? (rate 1-5 and add optional comment)
3. Was there any important information missing? (optional comment)
4. Would you make this recipe again? (rate 1-5 and add optional comment)

Standard Usability Scale questions

Rate all on scale 1-5

1. I think I would like to use this system frequently
2. I found the system unnecessarily complex
3. I thought the system was easy to use
4. I think I would need the help of a technical person to use this system
5. I found the various functions in this system were well integrated
6. I thought there was too much inconsistency in this system
7. I would imagine that most people would learn to use this system very quickly
8. I found the system very cumbersome to use
9. I felt very confident using the system
10. I needed to learn a lot things before I could get going on this system

C. Informed consent form for RECIPE1 study

Informed consent

Research project : Digital recipes

Research activity : Usability study of recipe software

Date : June 2011

Researcher : Lucy Buykx

Supervisor : Helen Petrie

Please read the following statements and sign at the bottom to indicate your consent to participate.

1. The purpose and procedure of my participation has been explained to me.
2. I acknowledge that
    a. My activities in the kitchen will be videoed for later analysis
    b. Video analysis will be performed by the primary researcher and other members of the HCI research group
    c. Short clips and stills from the video may be used for publication. Any identifying information will be omitted or disguised.
3. I further acknowledge that
    a. My participation is voluntary
    b. My participation will take about 3 hours of my time
    c. I have been informed that I may withdraw at any time and if I do then my contribution will be removed from the research analysis
4. I consent to participate

Participant name ____

Signature ____

Date _____________________________________

Appendix 4 Recipes for RECIPE1 study

Table 78: Recipe Presentation levels for Burgers Recipe

Recipe Presentation	Control	Segmented Instructions	Integrated Instructions
Ingredient list	1 small onion 1 garlic clove 1 small lemongrass stalk 200 g minced chicken 30 g fresh white breadcrumbs 1 tablespoon chopped fresh coriander 1 teaspoon finely grated lime zest 1 teaspoon fish sauce 1 teaspoon caster sugar light flavoured oil, such as rapeseed, for brushing	1 small onion 1 garlic clove 1 small lemongrass stalk 200 g minced chicken 30 g fresh white breadcrumbs 1 tablespoon chopped fresh coriander 1 teaspoon finely grated lime zest 1 teaspoon fish sauce 1 teaspoon caster sugar light flavoured oil, such as rapeseed, for brushing	1 small onion 1 garlic clove 1 small lemongrass stalk 200 g minced chicken 30 g fresh white breadcrumbs 1 tablespoon fresh coriander 1 lime 1 teaspoon fish sauce 1 teaspoon caster sugar light flavoured oil, such as rapeseed, for brushing
Method instructions	1. Peel and finely grate the onion and peel and crush the garlic. Finely chop the white part of the lemongrass, then place with the chicken, onion, breadcrumbs, garlic, coriander, lime zest, fish sauce and sugar in a large bowl and mix well with your hands. Shape into 2 patties, cover and chill for at least 10 minutes. 2. Heat a barbecue or griddle pan until hot. Brush the burgers with a little oil and cook for 4 minutes on each side or until cooked through. Serve the burgers in soft rolls with lettuce, mint, coriander and chilli sauce.	1. Peel and finely grate the onion. 2. Peel and crush the garlic. 3. Finely chop the white part of the lemongrass. 4. Place the chicken, onion, breadcrumbs, garlic, coriander, lime zest, lemongrass, fish sauce and sugar in a large bowl. 5. Mix well with your hands. 6. Shape into 2 patties. 7. Cover and chill for at least 10 minutes. 8. Heat a barbecue or griddle pan until hot. 9. Brush the burgers with a little oil. 10. Cook for 4 minutes on each side or until cooked through. 11. Serve the burgers in soft rolls with lettuce, mint, coriander and chilli sauce.	1. Peel and finely grate 1 onion and place in a large bowl. 2. Peel and crush 1 garlic clove, add to the bowl. 3. Finely chop the white part of 1 lemongrass stalk, add to the bowl. 4. Chop a sprig coriander leaves, add 1 tablespoon of leaves to the bowl. 5. Zest 1 lime. Add 1 teaspoon of the zest to the bowl. 6. Add the 200g chicken, 30g breadcrumbs, 1 teaspoon fish sauce and 1 teaspoon sugar to the bowl. 7. Mix well with your hands. 8. Shape into 2 burgers. 9. Cover and chill for at least 10 minutes. 10. Heat a barbecue or griddle pan until hot. 11. Brush the burgers with a little oil. 12. Cook for 4 minutes on each side or until cooked through. 13. Serve the burgers in soft rolls with lettuce, mint,

			coriander and chilli sauce.

Table 79: Recipe presentation levels for Dip Recipe

Recipe Presentation	Control	Segmented Instructions	Integrated Instructions
Ingredient list	50 g dried black beans 1 tablespoon olive oil 1/2 small red pepper, deseeded and thinly sliced 1 small red onion, thinly sliced 1 teaspoon ground cumin 1 garlic clove, finely chopped 2 tomatoes, chopped 1 small red chilli, finely chopped 1 tablespoon red wine vinegar 125 ml passata 100 g feta cheese, crumbled corn chips, to serve	50 g dried black beans 1 tablespoon olive oil 1/2 small red pepper, deseeded and thinly sliced 1 small red onion, thinly sliced 1 teaspoon ground cumin 1 garlic clove, finely chopped 2 tomatoes, chopped 1 small red chilli, finely chopped 1 tablespoon red wine vinegar 125 ml passata 100 g feta cheese, crumbled corn chips, to serve	50 g dried black beans, or 100g canned red kidney beans 1 tablespoon olive oil 1/2 small red pepper 1 small red onion 1 teaspoon ground cumin 1 garlic clove 2 tomatoes 1 small red chilli 1 tablespoon red wine vinegar 125 ml passata **Topping** 100 g feta cheese **To serve** corn chips
Method instructions	1. Soak the black beans in cold water overnight. Drain and rinse well. Put them in a large saucepan with plenty of water and bring to the boil. Cook for 25-30 minute, until soft to the bite. Drain well and set aside. 2. Heat the oil in a saucepan set over high heat and add the red pepper and onion. Reduce the heat to low, cover and cook for about 8 minutes. Add the cumin, garlic and chillies and cook for a further 2 minutes. Add the beans, tomatoes, vinegar and passata and bring to the boil. Reduce the heat and simmer rapidly for 10 minutes, until almost all the liquid has evaporated and the tomatoes start to look mushy. 3. Preheat the grill to high. 4. Transfer the bean	1. Soak the black beans in cold water overnight. 2. Drain and rinse well. 3. Put them in a large saucepan with plenty of water. 4. Bring to the boil. 5. Cook for 25-30 minutes, until soft to the bite. 6. Drain well. 7. Set aside. 8. Heat the oil in a saucepan set over high heat. 9. Add the red pepper and onion. 10. Reduce the heat to low. 11. Cover and cook for about 8 minutes. 12. Add the cumin, garlic and chillies. 13. Cook for a further 2 minutes. 14. Add the beans, tomatoes, vinegar and passata. 15. Bring to the boil. 16. Reduce the heat. 17. Simmer rapidly for 10 minutes, until almost all the liquid has evaporated and the tomatoes start to look mushy. 18. Preheat the grill to high. 19. Transfer the bean mixture to a flameproof	1. Soak 50g black beans in cold water overnight OR use 100g canned red kidney beans and skip to step 7. 2. Drain and rinse well. 3. Put them in a large saucepan with plenty of water. 4. Bring to the boil. 5. Cook for 25-30 minutes, until soft to the bite. 6. Drain well and set aside. 7. Deseed 1/2 red pepper and slice thinly and place on a small dish. 8. Thinly slice 1 red onion. Add to the red pepper. 9. Finely chop 1 garlic clove and place on another small dish. 10. Finely chop 1 red chilli. Add to the garlic. 11. Add 1 teaspoon ground cumin to the chilli and garlic. 12. Chop 2 tomatoes. 13. Heat the oil in a saucepan set over high heat. 14. Add the red pepper and onion. 15. Reduce the heat to low. 16. Cover and cook for about 8 minutes. 17. Add the cumin, garlic and chillies. 18. Cook for a further 2 minutes. 19. Add the beans, tomatoes, 1tablespoon vinegar and 125ml

	mixture to a flameproof dish and sprinkle the crumbled feta over the top. Cook under the hot grill until the cheese is soft and just starting to brown. Serve hot with corn chips on the side for dipping.	dish. 20. Sprinkle the crumbled feta over the top. 21. Cook under the hot grill until the cheese is soft and just starting to brown. 22. Serve hot with corn chips on the side for dipping.	passata. 20. Bring to the boil. 21. Reduce the heat. 22. Simmer rapidly for 10 minutes, until almost all the liquid has evaporated and the tomatoes start to look mushy. 23. Preheat the grill to high. 24. Transfer the bean mixture to a flameproof dish. 25. Crumble 100g feta cheese. 26. Sprinkle the crumbled feta over the top of the bean mixture. 27. Cook under the hot grill until the cheese is soft and just starting to brown. 28. Serve hot with corn chips on the side for dipping.

Appendix 5 Materials for RECIPE2 study

A. Participant cooking experience questionnaire

How many times a week do you cook?

Thinking about cooking everyday meals, do you

[select one of: sometimes | most of the time | rarely]

- Cook with ready meals
- Cook from scratch (raw ingredients)
- Reheat left overs
- Cook with prepared ingredients (e.g. pasta sauce, pizza bases, fish fingers)
- Other

Thinking about everyday cooking, how many people do you usually cook for (including yourself)?

How do you rate your cooking skills?

- Little or none
- Know enough to get by, but not how to prepare a great variety of food
- Can prepare a simple meal without much problem
- Can prepare a good range of dishes, occasionally try new techniques
- Can prepare many dishes and regularly try new techniques and recipes

When did you learn to cook? And how? E.g. school, from my parents, from cookbook

In the last month, how many times have you cooked with a written recipe?

Thinking about the last time you used a recipe, where did it come from?

- Cookbook
- Magazine
- Supermarket recipe card
- Internet
- Family or friend
- Package label

Did you follow the recipe

- To the letter
- Substitute/omit/add ingredients(s)
- Alter the preparation/cooking instructions
- Merge it with other recipes

As you cooked, what did you read the recipe from?

- Cookbook/magazine i.e. printed copy
- Print out from internet

- Laptop
- Ipad or other tablet
- Smartphone

What is your age

What is your gender

What course are you studying?

B. Pre-cooking questionnaire: Salad Recipe

Potato, bean and tomato salad with gremolata

Simple to make, stunning to look at and great to eat - what more could you want! Gremolata is an aromatic mixture of zesty lemon, pungent garlic and flavourful flat-leaf parsley. Serve this salad warm or cold, with plenty of crusty bread to mop up all those tasty juices.

Ingredients

- 225 g small new potatoes, scrubbed, cut into bite-sized pieces if necessary
- 100 g runner beans, cut diagonally into slices
- 325 g ripe mixed tomatoes, (e.g. plum tomatoes, quartered lengthways; yellow and red cherry tomatoes, halved; beefsteak tomatoes, cut into wedges)
- 2 salad onions, thinly sliced
- 100 g young spinach leaves
- 1 ripe tomato, peeled and seeded
- ½ tablespoon pesto
- salt and freshly ground black pepper
- For the gremolata
- 1 small lemon
- 1 fat garlic clove, finely chopped
- handful of flat-leaf parsley, roughly torn

Please answer the questions below

After reading the introduction, rate how easy you think the recipe is

Scale: [very easy 1 – 7 very difficult]

How confident are you in making it?

Scale: [very unsure 1 – 7 very confident]

C. Pre-cooking questionnaire: Linguini Recipe

Linguini with mince

Traditional Bolognese sauce is simple to make but takes about 2 hours to cook. Therefore here is the Italian housewife's quick alternative which does not include tomato and only takes about 5 minutes to make. For this recipe, it is best to get really good quality, organic steak mince.

Ingredients

- 180 g long pasta, such as tagliatelle, linguine or spaghetti
- 40 ml extra virgin olive oil
- 1 garlic clove, very finely chopped
- 1 bay leaf
- 175 g steak mince
- 1/2 carrot, very finely chopped or grated
- 50 ml white wine
- salt and pepper
- small handful of fresh parsley, finely chopped
- 20 g pecorino or Parmesan cheese, freshly grated

Please answer the questions below

After reading the introduction, rate how easy you think the recipe is

Scale: [very easy 1 – 7 very difficult]

How confident are you in making it?

Scale: [very unsure 1 – 7 very confident]

D. Pre-cooking questionnaire: Cake Recipe

Microwave coffee and walnut cake

Easy to make. Prep 15 mins. Cook 10 mins.

Ingredients

- 85 g very soft butter
- 85 g golden caster sugar
- 2 eggs, beaten
- 85 g selfraising flour
- 2 tsp instant coffee powder
- small handful walnut pieces (optional)
- **For the buttercream**
- 1 tsp instant coffee powder
- 1 tsp milk
- 25 g very soft butter
- 100 g icing sugar

Please answer the questions below

After reading the introduction, rate how easy you think the recipe is

Scale: [very easy 1 – 7 very difficult]

How confident are you in making it?

Scale: [very unsure 1 – 7 very confident]

E. Post-cooking questionnaire: for recipes in Control Recipe Presentation

Were the instructions clearly written?

Scale: [very unclear 1 – 7 very clear]

Were the instructions well organised?

Scale: [very poorly organised 1 – 7 very well organised]

Were the instructions easy to understand?

Scale: [very easy 1 – 7 very difficult]

Did the instructions contain sufficient information?

Scale: [not enough information 1 – 7 too much information]

If there was not enough information, what other information should be included? [free text]

How confident were you making the recipe?

Scale: [very unsure 1 – 7 very confident]

Rate the ease of making this recipe?

Scale: [very easy 1 – 7 very difficult]

What did you like best about the recipe and how it was presented? [free text]

What did you like least about the recipe and how it was presented? [free text]

F. Post-cooking questionnaire: for recipes in Segmented-with-pictures and Overview Recipe Presentations

Were the instructions clearly written?

Scale: [very unclear 1 – 7 very clear]

Were the instructions well organised?

Scale: [very poorly organised 1 – 7 very well organised]

Were the instructions easy to understand?

Scale: [very easy 1 – 7 very difficult]

Did the instructions contain sufficient information?

Scale: [not enough information 1 – 7 too much information]

If there was not enough information, what other information should be included? [free text]

How confident were you making the recipe?

Scale: [very unsure 1 – 7 very confident]

How useful were the pictures?

Scale: [very un-useful 1 – 7 very useful]

Were there sufficient pictures?

Scale: [not enough 1 – 7 too many]

Rate the ease of making this recipe?

Scale: [very easy 1 – 7 very difficult]

What did you like best about the recipe and how it was presented? [free text]

What did you like least about the recipe and how it was presented? [free text]

Appendix 6 Recipes for RECIPE2 study

A. Salad Recipe

Control Recipe Presentation

Potato, bean and tomato salad with gremolata

Simple to make, stunning to look at and great to eat - what more could you want! Gremolata is an aromatic mixture of zesty lemon, pungent garlic and flavourful flat-leaf parsley. Serve this salad warm or cold, with plenty of crusty bread to mop up all those tasty juices.

- 225 g small new potatoes, scrubbed, cut into bite-sized pieces if necessary
- 100 g runner beans, cut diagonally into slices
- 325 g ripe mixed tomatoes, (e.g. plum tomatoes, quartered lengthways; yellow and red cherry tomatoes, halved; beefsteak tomatoes, cut into wedges)
- 2 salad onions, thinly sliced
- 100 g young spinach leaves
- 1 ripe tomato, peeled and seeded
- ½ tablespoon pesto
- salt and freshly ground black pepper
- For the gremolata
- 1 small lemon
- 1 fat garlic clove, finely chopped
- handful of flat-leaf parsley, roughly torn

1. Cook the potatoes in a large pan of lightly salted boiling water for 10-12 minutes or until just tender. Add the runner beans and cook for a further 2 minutes. Then drain and rinse under cold running water.
2. Toss the potatoes and beans with the mixed tomatoes, salad onions and spinach and season to taste.
3. For the gremolata, use a vegetable peeler to pare thin strips of rind from the lemon. Carefully remove as much white pith as possible (this is bitter). Finely chop the lemon rind and toss with the garlic and parsley. Season and set aside. Squeeze the juice from the lemon and whizz in a food processor with the peeled tomato and pesto for 10-15 seconds. Pour over the potato mixture and toss through. Scatter over the gremolata to serve.

Segmented-with-pictures Recipe Presentation

1. Cook the potatoes in a large pan of lightly salted boiling water for 10-12 minutes or until just tender.
2. Add the runner beans and cook for a further 2 minutes.
3. Then drain and rinse under cold running water.
4. Toss the potatoes and beans with the mixed tomatoes, salad onions and spinach and season to taste.
5. For the gremolata, use a vegetable peeler to pare thin strips of rind from the lemon.
6. Carefully remove as much white pith as possible (this is bitter).
7. Finely chop the lemon rind
8. Toss lemon rind with the garlic and parsley.
9. Season and set aside.
10. Squeeze the juice from the lemon.
11. Whizz in a food processor with the peeled tomato and pesto for 10-15 seconds.
12. Pour over the potato mixture and toss through.
13. Scatter over the gremolata to serve.

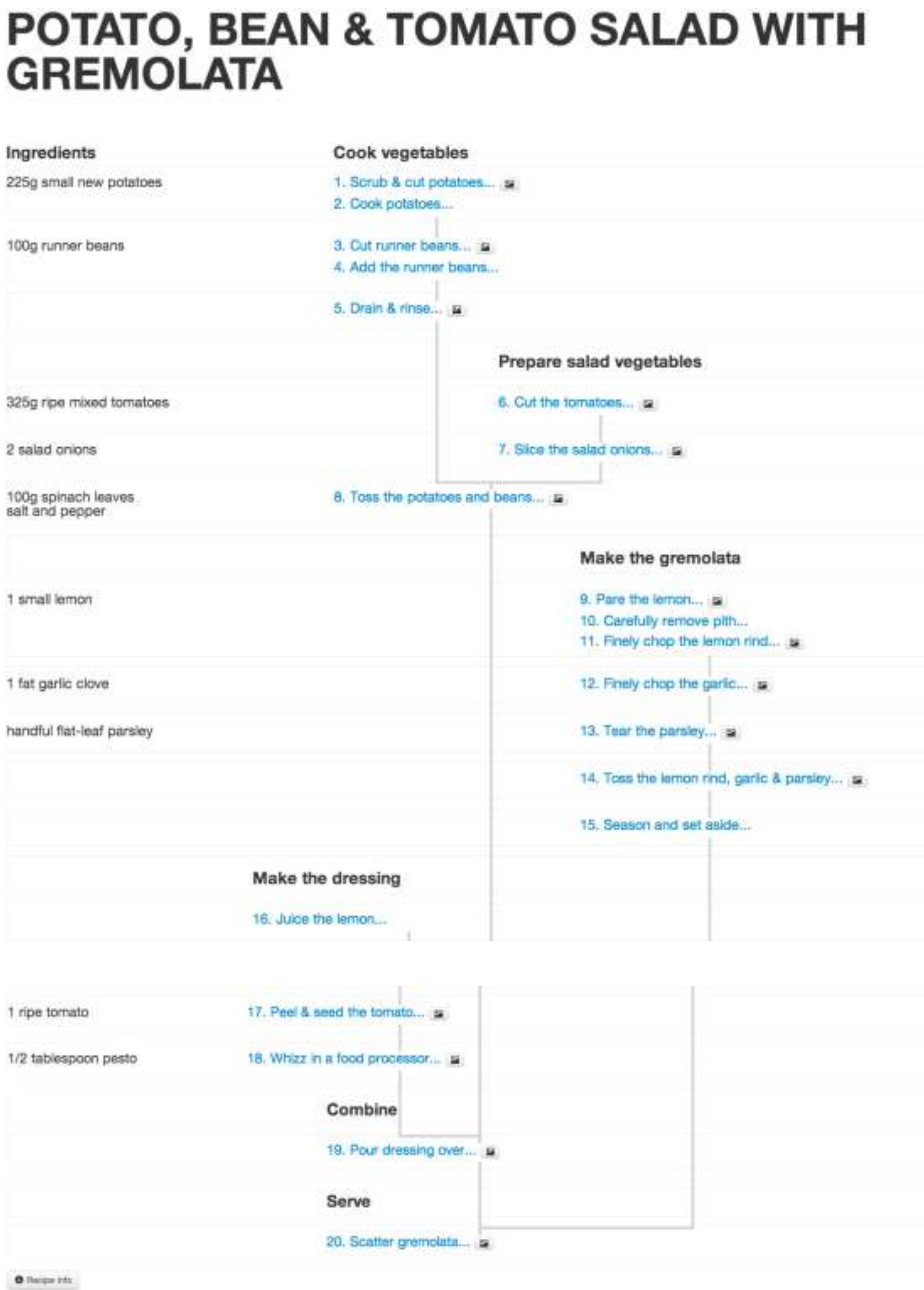
Pictures for Salad Recipe in Segmented-with-pictures Recipe Presentation

 *Step 3*	 *Step 4*
 *Step 5*	 *Step 7*
 *Step 8*	 *Step 11*

	
Step 12	*Step 13*

Figure 90: Pictures for Salad Recipe in Segmented-with-pictures Recipe Presentation

Overview Recipe Presentation



Pictures for Salad Recipe in Overview Recipe Presentation

 *Step 1*	 *Step 3*
 *Step 5*	 *Step 6*
 *Step 7*	 *Step 8*

 *Step 9*	 *Step 11*
 *Step 12*	 *Step 13*
 *Step 14*	 *Step 17*
 *Step 18*	 *Step 19*

 *Step 20*	

Figure 91: Pictures for Salad Recipe in Overview Recipe Presentation

B. Linguini Recipe

Control Recipe Presentation

Linguini with mince

Traditional Bolognese sauce is simple to make but takes about 2 hours to cook. Therefore here is the Italian housewife's quick alternative which does not include tomato and only takes about 5 minutes to make. For this recipe, it is best to get really good quality, organic steak mince.

- 180 g long pasta, such as tagliatelle, linguine or spaghetti
- 40 ml extra virgin olive oil
- 1 garlic clove, very finely chopped
- 1 bay leaf
- 175 g steak mince
- 1/2 carrot, very finely chopped or grated
- 50 ml white wine
- salt and pepper
- small handful of fresh parsley, finely chopped
- 20 g pecorino or Parmesan cheese, freshly grated

1. Bring a large saucepan of slightly salted water to the boil and cook the pasta until al dente.
2. Meanwhile, heat the olive oil, garlic and bay leaf in a frying pan and sweat the garlic. Reduce the heat to medium, add the mince and carrot, and cook for about 8 minutes, stirring all the time, until the meat is nearly cooked.
3. Pour in the wine, add the parsley, season with salt and pepper, and continue stirring until the wine has evaporated.
4. Drain the cooked pasta and add to the meat sauce with a couple of tablespoons of the pasta water. Mix well, sauté for a minute, remove from the heat and serve immediately with the grated cheese.

Segmented-with-pictures Recipe Presentation

1. Bring a large saucepan of slightly salted water to the boil and cook the pasta until al dente.
2. Meanwhile, heat the olive oil, garlic and bay leaf in a frying pan and sweat the garlic.
3. Reduce the heat to medium.
4. Add the mince and carrot, and cook for about 8 minutes, stirring all the time, until the meat is nearly cooked.
5. Pour in the wine, add the parsley, season with salt and pepper, and continue stirring until the wine has evaporated.
6. Drain the cooked pasta.
7. Add to the meat sauce with a couple of tablespoons of the pasta water.
8. Mix well, sauté for a minute.
9. Remove from the heat.
10. Serve immediately with the grated cheese.

Pictures for Linguini Recipe in Segmented-with-pictures Recipe Presentation

 *Step 2*	 *Step 4*
 *Step 5*	 *Step 8*
 *Step 10*	

Figure 92: Pictures for Linguini Recipe in Segmented-with-pictures Recipe Presentation

Overview Recipe Presentation

Pictures for Linguini Recipe in Overview Recipe Presentation

Step 2

Step 3

Step 5

Step 6

Step 7

Step 8

 *Step 9*	 *Step 11*
 *Step 13*	 *Step 14*

Figure 93: Pictures for Linguini Recipe in Overview Recipe Presentation

C. Cake Recipe

Control Recipe Presentation

Microwave coffee and walnut cake

Easy to make. Prep 15 mins. Cook 10 mins.

- 85 g very soft butter
- 85 g golden caster sugar
- 2 eggs, beaten
- 85 g selfraising flour
- 2 tsp instant coffee powder
- small handful walnut pieces (optional)
- **For the buttercream**
- 1 tsp instant coffee powder
- 1 tsp milk
- 25 g very soft butter
- 100 g icing sugar

1. In a medium bowl, beat the butter and sugar together until light and fluffy. Gradually add the eggs followed by the flour and instant coffee. Stir most of the walnuts (if using) into the batter, reserving a few for decoration. Transfer to a microwaveproof dish and cook on full power for 2 mins. Reduce the power to medium and cook for 2 mins.
2. After 4 mins, check to see if the cake is cooked it should be risen and spring back when touched. If it needs a bit longer, cook on medium for 1 min more at a time, checking after each minute until the cake is cooked. Remove and allow to cool.
3. Meanwhile, make the coffee butter cream. Dissolve the coffee in the milk, then add the butter and icing sugar. Beat until smooth, spread over the cake and top with the reserved walnuts.

Segmented-with-pictures Recipe Presentation

1. In a medium bowl, beat the butter and sugar together until light and fluffy.
2. Gradually add the eggs.
3. Add the flour and instant coffee.
4. Stir in most of the walnuts (if using) into the batter, reserving a few for decoration.
5. Transfer to a microwave-proof dish.
6. Cook on full power for 2 mins.
7. Reduce the power to medium and cook for 2 mins.
8. After 4 mins, check to see if the cake is cooked it should be risen and spring back when touched.
9. If it needs a bit longer, cook on medium for 1 min more at a time, checking after each minute until the cake is cooked.
10. Remove and allow to cool.
11. Meanwhile, make the coffee butter cream. Dissolve the coffee in the milk.
12. Then add the butter and icing sugar.
13. Beat until smooth.
14. Spread over the cake.
15. Top with the reserved walnuts.

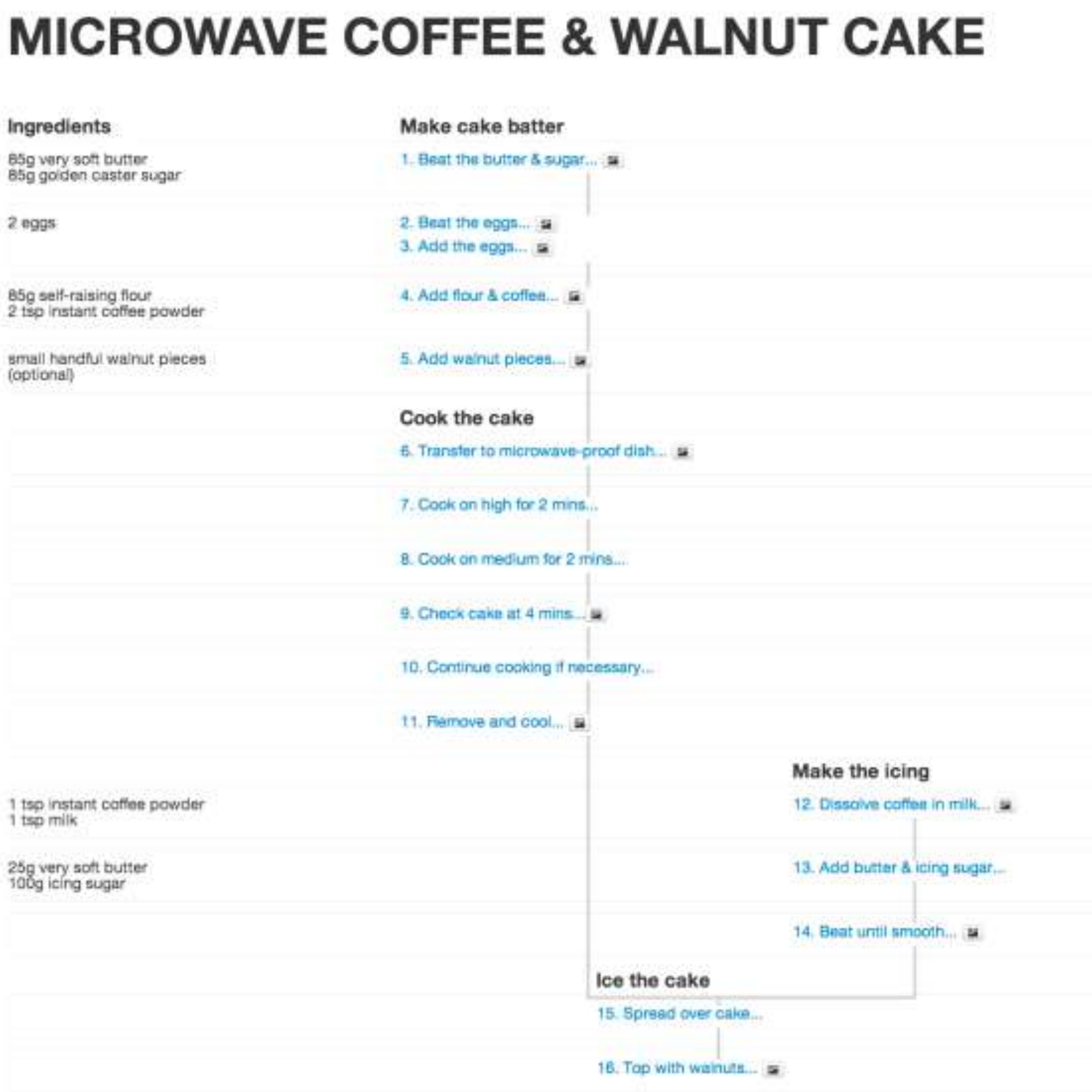
Pictures used for Cake Recipe in Segmented-with-pictures Recipe Presentation

 ***Step 1***	 ***Step 2***
 ***Step 3***	 ***Step 4***
 ***Step 5***	 ***Step 8***

 ***Step 10***	 ***Step 11***
 ***Step 13***	 ***Step 15***

Figure 94: Pictures for Cake Recipe in Segmented-with-pictures Recipe Presentation

Overview Recipe Presentation



Pictures used for Cake Recipe in Overview Recipe Presentation

 *Step 1*	 *Step 2*
 *Step 3*	 *Step 4*
 *Step 5*	 *Step 6*
 *Step 9*	 *Step 11*


Step 12


Step 14


Step 16

Figure 95: Pictures for Cake Recipe in Overview Recipe Presentation

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