A Smartphone-Based System to Manage Snacking in the Lower Socio-Economic Population

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ABSTRACT

This paper describes the design, implementation and evaluation of a smartphone phone application that provides users with the ability to manage their snacking habits, which has been documented as one of the main contributors to low socioeconomic population's poor diets. This application provides four key functions: (1) track users' snacking history; (2) view users' snacking history; (3) compare a user's snack healthiness with that of other family members; and (4) provide snack suggestions based on users' snacking history. The system design was first evaluated and revised using a cognitive walkthrough. We conducted a detailed user study of the final system prototype to assess the utility of the application.

Keywords

Healthy snack recommendation, low socio-economic status, smartphone application, usability.

1. INTRODUCTION

Poor diet is one of the most influential factors contributing to the obesity epidemic in the United States. Earlier research showed a strong link between poor dietary choices and the increased risk of cardiovascular disease in low socioeconomic status (SES) populations, a trend that starts as early as preschool [1, 4].

In an effort to provide the tools and resources needed for a low SES population to manage their diets, thereby reducing their chances of contracting cardiovascular disease (CVD), the use of technology has been heralded as an effective and accessible avenue [9]. However, further research shows that low SES populations often have trouble utilizing technology developed to manage and aid their diets [3]. Thus, there is a critical need to create accessible technology that is easily usable and has the capability to record, recommend, inform, and compare the dietary choices of the user. An example of such a technology is a smartphone application, access to which is more likely than access to a computer in the low SES population [9].

This paper describes the design, implementation and evaluation of a smartphone-based application to manage snacking in low SES populations. The purpose of this application is to provide a tool for people to manage and improve their snacking habits to help improve their diets and overall health. This application allows users to conveniently enter the snacks they consume and reflect on their snack history. Snacks are rated on a scale of 1-3 in terms of the impact on the teeth, heart and physical body. An overall healthiness of not healthy, moderately healthy and very healthy is displayed in the snacking history using color-coded text – red for not healthy, yellow for moderately healthy, and green for very healthy. For example, if the user tends to eat many poor snacks, then the text displaying their snacking history will be red. The application also allows users to compare their snack with the snacks consumed by their family members. Finally, the application provides recommendations for alternate (healthier) and compatible snacks. This recommendation is computed based on the current snacks that the user is consuming.

We built an application prototype for smartphones running Android operating system (version 2.2). The application was written in JAVA and used the SQLite database. This prototype has been extensively evaluated first via cognitive walkthrough, a commonly used inspection method, and then via a user study. We iteratively improved the prototype based on the results of each usability method.

The specific contributions of this paper are:

1. A system that addresses the rampant prevalence of unhealthy snacking habits in low SES populations that leads to a poor diet and places them at high risk for contracting CVD.
2. The exploration of a prototype adaptable system that creates recommendations based on the "current diet" of the user. This has the potential to have a much greater impact on the user's snacking choices than traditional generic messages such as "eat better" than can often be seen on the front of package labels and logos that have been developed by manufacturers and organizations (e.g., Kraft Foods Sensible Solutions, American Heart Association Heart Check program) to highlight the nutritional benefits of individual products.
3. The documentation of an iterative design process to create a very simple, user-friendly interface that the members of low SES population will be capable and motivated to use.

2. RELATED WORK

Siek and Maitland showed that technology widely accessible to low SES populations (such as mobile phone technology) and can be used as an effective tool in overcoming certain health barriers. The paper goes on to detail that the design of this technological tool needs to include capabilities such as convenient meal planning and a sense of community to be truly effective [8]. Additionally, they mention the need for the application to provide solutions that resonate with the user, and does not seem as though the user is being told what to do, without initially showing the inherent value of the shift. This paper extends that idea by centering recommendations for the user on the snacks that have been previously entered, thus personalizing them, and making them more applicable to the user. The recommendations themselves act as an automatic and quickly convenient snack planning, and the snack history and recommendations are broken down into health benefits and impacts to help give the user a better understanding of the value of moving towards healthier snacking habits.

Researchers at the University of Colorado showed that any sort of assistive technology needs to be convenient and integrated with the family as a whole, further noting that the caregivers are the key in modifying family health. Additionally, they called for a design that gives users "meaningful and actionable advice" [9]. This paper incorporates that idea by making the application a family based application, so that the caregiver in particular can track snacking habits and modify them as necessary, and gives recommendations that are personalized. The application also gives users a check on their progress by assigning their snacking habits a healthiness level.

3. METHODS

The initial design of the proposed smartphone based system has been evaluated using a cognitive walkthrough. Developed in 1992, a cognitive walkthrough is "a formalized way of imagining people's thoughts and actions when they use an interface for the first time" [5, 7]. It consists of identifying each task, breaking the task down into steps, and asking four key questions about each step. Rather than simply allowing a free romp through the interface, cognitive walkthroughs require a task to be performed, along with a realistic story behind the motivations of the user for desiring to fulfill that task. If a believable motivation for the task cannot be created, there is a significant usability error. The next important step is to identify a list of correct action sequences to fulfill the task. As you walk through each step, the following four key questions are asked: A) Intent: Will users be trying to produce whatever effect the action has?; B) Visibility: Will users see the control (button, menu, switch, etc.) for the action?; C) Labeling: Once users find the control, will they recognize that it produces the effect they want?; and D) Feedback: After the action is taken, will users understand the feedback they get, so that they can go on to the next action with confidence? Based on this, the data that is collected is essentially a formalized thought process of the user as they go through the action sequence. Cognitive walkthrough has been heralded as one of the most effective usability studies in software testing. It allows for appropriate managing of resources.

The user studies were analyzed using QSR International's NVivo 10 software (http://www.qsrinternational.com). This software allowed for the user study videos to be transcribed and coded at "nodes". These nodes are essentially groupings of user statements and actions that allow for design themes (flaws and successes) to become apparent.

4. SYSTEM DESIGN

The overall system architecture of the proposed system is shown in Figure 1. There are three logical components: Database, recommendation engine and mobile client. These three logical components may be implemented on the same device. All of the components have clearly defined functionalities that are easily extendible or portable. The database stores individual and family profiles including snacking history. The database gets updated every time a new snack is entered by the user. Optionally, the database may also store known health conditions of the users, which can be used to make health-specific recommendations. The recommendation engine computes appropriate snack recommendation for the user. Currently, this recommendation is simply based on the recent snacking history of the user. However, the recommendation engine can easily be extended to provide highly customized individual or family based recommendations by incorporating other useful features such as age, gender, ethnicity and health conditions of the user and family members. Finally, the mobile client provides a user interface through which a user may interact with the system. This interface is simple, easy to use and intuitive, and guides the users to their goals through informative content. This component is discussed in detail in the subsections below.

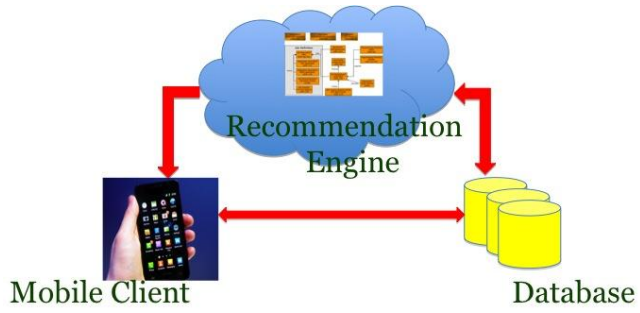


Figure 1. System Architecture

4.1 Functionality

The mobile component provides four important functionalities: (1) the ability to track user snacking by allowing the user to enter in their daily snacks from a predefined list; (2) the ability for the user to view his/her own snacking history based on his/her previous snack tracking; (3) the ability for the user to compare their own snack healthiness to the snack healthiness of other members of their family (provided that other family members are also recording their snacks in the same application); and (4) the ability to view snack suggestions based on the user's previous snack tracking.

4.2 Initial Design

The initial design of the mobile application is shown in Figure 2. There are five separate screens with a logical flow between different screens. The five screens are titled "Application Home", "Enter Snack Page", "Personal Snack History", "Snack Recommendations" and "Family Snack History".

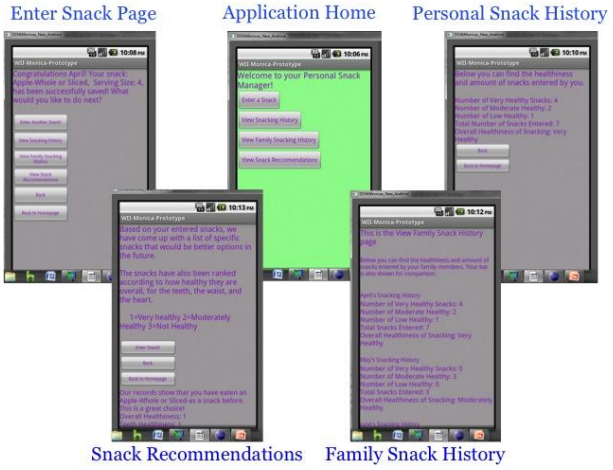


Figure 2. Initial design: Five screens of the mobile client.

When the mobile client is started, the Application Home screen is displayed. This screen provides four buttons: "Enter a Snack," "View Snacking History," "View Family Snacking History," and "View Snack Recommendations." Activating these buttons takes

the user to a different screen: Enter Snack Page, Personal Snack History, Family Snack History and Snack Recommendations respectively. In addition to other information, each of these four screens include a "Back" button to take the user to the previous screen and a "Back to Homepage" button to take the user to Application Home screen. The Enter a Snack screen includes a dropdown menu from which the user may choose a snack to enter. After entering a snack, a new screen appears that includes a confirmation message and buttons to enter another snack as well as to go to the other screens. The Personal Snack History screen displays the healthiness of the snacks consumed by the user. This includes a count of very healthy, moderate healthy and low healthy snacks as well as an overall healthiness rating. The Family Snack History screen displays similar healthiness information for each of the family members. Finally, the Snack Recommendation screen provides recommendations for healthy snacks along with how healthy they are overall, for the teeth, for the waist and for the heart. For the Enter a Snack, Personal Snack History, and the Snack Recommendation screen, there is an additional field of username, from which the user selects their name from a dropdown menu before submitting the snack or gaining access to the personal snacking history or recommendations.

Cognitive Evaluation: Task List

Assumptions: For the purpose of this walkthrough, the persona of the user will be considered to be May.

Task One: Enter a Snack

1. Click on button labeled "Enter a Snack"
2. Click on the first spinner on the next page, directly underneath the text "Select User"
3. Select the option "May" from the resulting dropdown list
4. Click on the second spinner, directly underneath the text "Choose Snack"
5. Select the option "Pizza Slice-One Topping" from the resulting dropdown list
6. Click on the third spinner, directly underneath the text "Choose a Serving Size"
7. Select the option "3" from the resulting dropdown list
8. Click on the button labeled "Submit Snack!"
9. Click on the button "Back to Homepage" to exit the Enter Snack function

Task Two: View Personal Snacking History

1. Click on the button labeled "View Snacking History"
2. Click on the first spinner on the next page, directly underneath the text "Choose User to View"
3. Select the option "May" from the resulting dropdown list
4. Click on the button labeled "Next"
5. Click on the button "Back to Homepage" to exit the View Snack History function

Task Three: View Family Snacking History

1. Click on the button labeled "View Snacking History"
2. Scroll down to the end of the page
3. Click on the button "Back to Homepage" to exit the View Family Snack History function

Task Four: View Snack Recommendations

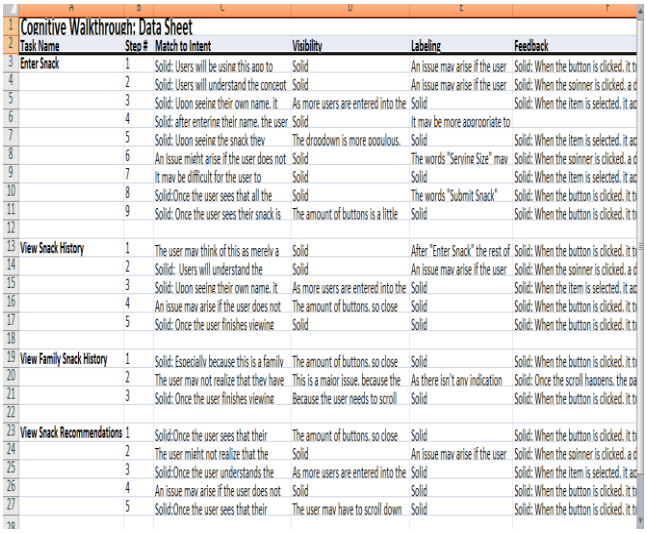
1. Click on the button labeled "View Snack Recommendations"
2. Click on the first spinner on the next page, directly underneath the text "Choose User to View"
3. Select the option "May" from the resulting dropdown list
4. Click on the button labeled "Next"
5. Click on the button "Back to Homepage" to exit the View Snack Recommendations function

Figure 3. Task list for cognitive evaluation.

4.3 Usability Study: Cognitive Walkthrough

For each of the four key functions in this application, we conducted a cognitive walkthrough to ensure that all or most of the possible usability errors are caught. This method is used to test usability before running real user studies for two key reasons: A) to catch any apparent issues with the interface/application; and B) to ensure that the data collected from the user studies provides insight that could not have been collected through inspection methods – thereby saving time and resources.

Figure 3 shows the task list for cognitive evaluation. The purpose of the cognitive walkthrough is to go through the ideal set of steps needed to take to complete the task, and evaluate each step This design was evaluated on four tasks: entering a snack, viewing the personal snacking history, viewing the family snacking history, and viewing the snack recommendations.



Cognitive Walkthrough: Data Sheet

Task Name	Step #	Match to Intent	Visibility	Labeling	Feedback
Enter Snack	1	Solid: Users will be using this app to	Solid	An issue may arise if the user	Solid: When the button is clicked, it t
	2	Solid: Users will understand the concept	Solid	An issue may arise if the user	Solid: When the soinner is clicked, a d
	3	Solid: Upon seeing their own name, it	As more users are entered into the	Solid	Solid: When the item is selected, it ac
	4	Solid: after entering their name, the user	Solid	It may be more appropriate to	
	5	Solid: Upon seeing the snack they	The droodown is more opaulous.	Solid	Solid: When the item is selected, it ac
	6	An issue might arise if the user does not	Solid	The words "Servine Size" may	Solid: When the soinner is clicked, a d
	7	It may be difficult for the user to	Solid	Solid	Solid: When the item is selected, it ac
	8	Solid:Once the user sees that all the	Solid	The words "Submit Snack"	Solid: When the button is clicked, it t
	9	Solid: Once the user sees their snack is	The amount of buttons is a little	Solid	Solid: When the button is clicked, it t
View Snack History	1	The user may think of this as merely a	Solid	After "Enter Snack" the rest of	Solid: When the button is clicked, it t
	2	Solid: Users will understand the	Solid	An issue may arise if the user	Solid: When the soinner is clicked, a d
	3	Solid: Upon seeing their own name, it	As more users are entered into the	Solid	Solid: When the item is selected, it ac
	4	An issue may arise if the user does not	The amount of buttons, so close	Solid	Solid: When the button is clicked, it t
	5	Solid: Once the user finishes viewing	Solid	Solid	Solid: When the button is clicked, it t
View Family Snack History	1	Solid: Especially because this is a family	The amount of buttons, so close	Solid	Solid: When the button is clicked, it t
	2	The user may not realize that they have	This is a major issue, because the	As there isn't any indication	Solid: Once the scroll happens, the pa
	3	Solid: Once the user finishes viewing	Because the user needs to scroll	Solid	Solid: When the button is clicked, it t
View Snack Recommendations	1	Solid:Once the user sees that their	The amount of buttons, so close	Solid	Solid: When the button is clicked, it t
	2	The user might not realize that the	Solid	An issue may arise if the user	Solid: When the soinner is clicked, a d
	3	Solid:Once the user understands the	As more users are entered into the	Solid	Solid: When the item is selected, it ac
	4	An issue may arise if the user does not	Solid	Solid	Solid: When the button is clicked, it t
	5	Solid:Once the user sees that their	The user may have to scroll down	Solid	Solid: When the button is clicked, it t

Figure 4. A sample of cognitive walkthrough data sheet.

Figure 4 shows a sample of the cognitive walkthrough data sheet. Only a small portion of this sheet is shown here for lack of space. We evaluated each step at each of the four categories, and wrote comments explaining any errors or observations for each category in each step.

Table 1. Breakdown of errors

Task	Intent	Visibility	Labeling	Feedback
Entering a snack	2	3	5	0
Viewing snack history	2	2	2	0
Viewing family snacking history	1	3	1	0
Viewing snack recommendation	2	3	1	0

Finally, Table 1 shows the breakdown of errors for the four functions. As we can see, the task that had the most errors was the Enter Snack function. These errors mainly dealt with the specifics of entering the snack in correctly; the biggest issue being the comprehension of the breakdown of snack portions (what is considered a serving size, how many portions were consumed, etc). Additionally, certain labeling issues arose, such as potential confusion over the term "user" instead of "family member" or something akin to that. Another key issue with not just the Enter Snack function, but the application layout overall, is visual confusion. This is likely why the visibility category had the most errors in this design. For example, the confirmation page after submitting a snack displayed six shortcut buttons, but displayed them linearly. This, coupled with the buttons' and the text's small size, may have lead to the wrong button accidentally being selected. Another major visibility issue for the future is the dropdown menus found, particularly in the Enter Snack function. In practice, as the user list grows, or as more snack options are

added to the database, the dropdown menu options face the issue of becoming smaller, and harder to select, thus leading to the user not being able to find a particular option, or not being able to properly select it.

4.4 Final Design

Based on the errors discovered from the cognitive walkthrough, the mobile component design has been revised as follows. This second iteration can be seen in Figure 5.

Figure 5. Second Design: Five screens of the mobile client.

The second iteration is based on a black background, as opposed to the initial design's green and purple, for maximum text readability. The five main screens and the logical flow between the screens are still the same as the initial design. This is because the functionality needed no clarification or additional flow.

However, when the mobile client is started, the user is initially prompted to select a user from a dropdown menu, before they gain access to the Application Home screen, thus eliminating one extra piece of information that the user is required to enter each time.

The Application Home screen provides the same four buttons that lead to the Enter Snack, View Snacking History, View Family Snacking History, and View Snack Recommendations pages, however, the buttons are substantially bigger, more spaced out, and centered. This allows the user to easily select the correct option. Activating these buttons still lead to the same screens as in the initial design. To maintain consistency, for all the pages except the View Family Snacking History and the View Snack Recommendations pages, at the bottom left of each screen is the "Back" button, and the bottom right is the "Back to Homepage" button. The View Family Snacking History and the View Snack Recommendations pages contain the "Back" and "Back to Homepage" buttons in a linear fashion underneath the instructional information at the top of the screen. This helps keep the buttons in plain sight, despite the pages' scrolling capability.

The Enter Snack page still contains two dropdown menus: one to select the snack quantity, and another to select the snack itself. When the user hits submit, the confirmation screen appears, along with shortcuts that access the Enter Snack, View Snacking History, View Family Snacking History, and View Snack Recommendations pages. Unlike the initial design, this version staggers the buttons horizontally, rather than display them linearly, which allows for less confusion, and more visual appeal.

The Personal Snack History has the same functionality and layout (except for some spacing and text resizing) as the original version, however, the text that displays the snacking summary turns a certain color based on the user's overall snacking healthiness (red for not healthy, yellow for moderately healthy, and green for very healthy), to give the user a visual gauge of the information presented in the summary. The Family Snack History works in the same way, listing all the family members' information linearly in a half screen scroll down (The information and back buttons stay stationary in the top half of the screen, while the snack history summaries are in the scrollable bottom half). Finally, the Snack Recommendation screen provides the same information as the original iteration, with the entire page being scrollable.

5. USER STUDY

The purpose of the user study is to test the second iteration with actual users to discover problems that might have not been detected by the usability study, and to observe the general user behavior with the application. For this study, eight adults (3 male, 5 female) were given a handheld mobile phone running the Android operating system (version 2.2) with the application preinstalled, and told to complete a set of tasks, as read to them by the researcher. For each user study, the application's memory was cleared, and certain snacks were pre-entered for the users that the participant would not assume the persona of, so that the View Family Snacking History could be displayed at maximum functionality. Figure 6 shows an example of the task list read to the female participants. For lack of space, only a portion of the list is shown.

Task List for Mobile Phone Snacking Application (Adult, June)

Background: June is a fairly typical middle aged suburban mother of 3. She works as an RN in the New Life center of a local hospital, and is an active member in her community's Book Bees book club and Mountain Mamas environmental awareness club. She works late at the hospital 3 days of the week, and usually is dashing between Book Bees and Mountain Mamas on the other days, and as a result, June is very busy, and has little time to devote towards thinking about her eating habits.

Task 1: Right before the end of her shift at the hospital, later that day, June eats a slice of leftover pizza from her lunch. Remembering her new app, she records the snack, and is surprised to see buttons that allow her to access her family's snacking history, her own snacking history, and snack recommendations. She decides to have her children track their snacking with this app too.

Task 2: After Mountain Mamas that day, June absentmindedly eats two bags of potato chips while completing her Book Bees book. Half way through, she remembers that she can enter this snack into her app.

Task 3: The next day, June arrives a few minutes too early to pick up her daughter, April, from theater practice, so she decides to explore her app to alleviate the social awkwardness. She has enough time to look through her own personal snacking history, and see what she's been eating over the last couple of days.

Task 4: While watching the latest episode of Survivor, June remembers the nutritional content associated with her snacking, and decides to see what the app recommends to make her snacking healthier.

Task 5: Based on the app's recommendation, June eats 3 apples, sliced, throughout the course of the next day. She happily enters them into her app.

Figure 6. User Study Task List-Adult Female Participant.

The participants were read a background for the persona that they were asked to portray when completing the requested tasks. This allowed for the participant to gain a better understanding of the intention and motives behind each task. The entire task list that the researcher read to the participant was constructed in story format, with breakdowns of task 1, task 2, etc. There were seven tasks that each participant (male or female) completed: Enter one slice of pizza, enter two servings of potato chips, view personal snacking history, view snack recommendations, enter three apples, view personal snacking history, and view family snacking history. The participants were prompted to use the "think aloud" method, and verbally explain why they were taking certain actions (pressing buttons, selecting options from dropdown menus, etc) to achieve the task, as well as any observations or frustrations they had while completing the tasks. The researcher would read the

task, and allow the participant to complete the task before reading the next task. The researcher remained silent during the participant's verbal navigation of the task, except for the occasional reminder to continue to process their information out loud.

5.1 Analysis

Each user study was filmed, with the camera showing only the mobile phone's screen, so that in addition to the participants' verbal feedback, general observations, such as shortcuts taken, hesitations in which buttons to select, and difficulty in selecting options, could be noted as well. These videos were uploaded on to a qualitative analysis software called QSR International's NVivo 10. Figure 7 shows the layout of the NVivo 10 loaded with one of the videos and its transcription to the right of it.

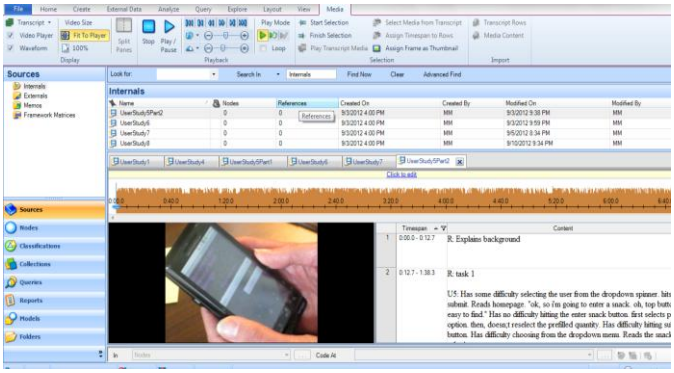
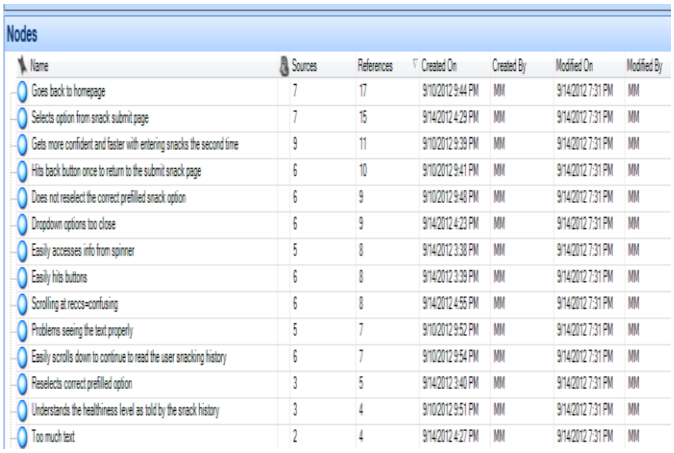


Figure 7. A sample of the layout of the NVivo 10 software.

The videos were then transcribed, with general observations also noted as they occurred in the video. This software allowed for the coding of "nodes". These nodes are essentially groupings of user statements and actions that allow for design themes (flaws and successes) to become apparent. After all the nodes were coded, the frequency and variability in certain themes became apparent. Figure 8 shows the node breakdown in order of most frequent to least frequent. For lack of space, not all nodes are shown.



Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
Goes back to homepage	7	17	9/10/2012 9:44 PM	MM	9/14/2012 7:31 PM	MM
Selects option from snack submit page	7	15	9/14/2012 4:29 PM	MM	9/14/2012 7:31 PM	MM
Gets more confident and faster with entering snacks the second time	9	11	9/10/2012 9:39 PM	MM	9/14/2012 7:31 PM	MM
Hits back button once to return to the submit snack page	6	10	9/10/2012 9:41 PM	MM	9/14/2012 7:31 PM	MM
Does not reselect the correct prefilled snack option	6	9	9/10/2012 9:48 PM	MM	9/14/2012 7:31 PM	MM
Dropdown options too close	6	9	9/14/2012 4:23 PM	MM	9/14/2012 7:31 PM	MM
Easily accesses info from spinner	5	8	9/14/2012 3:38 PM	MM	9/14/2012 7:31 PM	MM
Easily hits buttons	6	8	9/14/2012 3:39 PM	MM	9/14/2012 7:31 PM	MM
Scrolling at recos=confusing	6	8	9/14/2012 4:55 PM	MM	9/14/2012 7:31 PM	MM
Problems seeing the text properly	5	7	9/10/2012 9:52 PM	MM	9/14/2012 7:31 PM	MM
Easily scrolls down to continue to read the user snacking history	6	7	9/10/2012 9:54 PM	MM	9/14/2012 7:31 PM	MM
Reselects correct prefilled option	3	5	9/14/2012 3:40 PM	MM	9/14/2012 7:31 PM	MM
Understands the healthiness level as told by the snack history	3	4	9/10/2012 9:51 PM	MM	9/14/2012 7:31 PM	MM
Too much text	2	4	9/14/2012 4:27 PM	MM	9/14/2012 7:31 PM	MM

Figure 8. A sample of the node layout in order from most occurring to least occurring.

Thirty eight total nodes were recorded. Table 2 shows a basic breakdown of the most important nodes that indicated areas for improvement.

Table 2. A sample of the most important areas for improvement.

Nodes that Indicate an Area for Improvement	Number of Times the Node Occurs	Possible Modification to Design
User has issues correctly selecting an option from a dropdown menu (they accidentally hit the wrong one)	9	Increase dropdown menu option size
User has difficulty understanding page layouts (whether they are a full page scroll, or a half page scroll; most noted in the View Snack Recommendations and View Family Snacking History Page)	15	Switch to a tab or swipe method where rather than scrolling, the user simply clicks a "next" button or swipes the page to access the recommendations/history page after the instructional information. This maintains consistency throughout the design.
User does not wholly grasp significance of colored text or numerical rankings on their snacking habits	9	Move towards a more graphically representative way of displaying the snacking and drastically reducing the amount of text (e.g. colored bar charts displaying snacking history)
User desires to see a further nutritional breakdown of snacks	2	Adding a feature where if the user clicks on the history or recommendation, the app displays a further nutritional content breakdown (eg calories, grams of sugar, etc)

The three main areas for improvement that emerge from the nodes are: spacing, navigation, and specificity. In terms of spacing, 7 out of the 8 users had varying degrees of difficulty selecting the right option from the dropdown menus, which were "too small for my fat fingers," as one participant jovially put it. As more and more options will be added into the snack option list, this will become even more of an issue, and it is critical that users be able to easily view and select all the options correctly the first time. While the logical flow itself did not present any problems, navigation in terms of screen orientation did. Participants were confused that the View Snack Recommendations and the View Family Snack History pages needed to be scrolled in order to be accessed. This lead to 4 out of 8 users completely missing how to access the recommendations, and the other four issuing statements that the scrolling was confusing. Instead, a future design could include a tab feature, so that the user can simply swipe the screen or push a

"Next" button to be able to view all the information in a logical manner. The last key issue was specificity. This issue manifested itself in the feedback the user was receiving about their snacking habits. While the color coded text and numerical rankings were explained in the instruction information, 6 out of 8 participants failed to grasp its significance. Part of this might have to do with the fact that the application is "too text-y" and lacks graphics. Replacing number summaries with colored bars or some other visual representation may help provide the user with the feedback they are looking for. 2 out of the 8 participants also verbalized their desire to see a further nutritional breakdown (calories, sugar content, fat content, etc) in addition to the snack rankings.

The nodes also indicated several key observations that highlight positive functionality within the design that ought to be preserved in future iterations. These can be seen in Table 3.

Table 3. A sample of the most important indicators of positive design functionality.

Nodes that Indicate Positive Functionality	Number of Times the Node Occurs
Users indicate that entering a snack is very intuitive and easy to use. An increase in confidence and speed in entering a snack after the initial snack entry is observed.	**11**
Users display no confusion in which buttons indicate which function.	**8**
The shortcut to the other functions of the application from the Submit Screen displayed after the user successfully entered a snack allowed the user to skip the instructional information and go directly to their snacking information at a quicker pace as they got more familiar with the application.	**15**
Users are able to easily navigate between the screens using the "back" and "back to homepage" buttons, and show no trouble discerning which one to use.	**8**
Users had no issues understanding the specific language used in the application.	**N/A**

6. CONCLUSIONS AND FUTURE WORK

This paper describes the design, implementation and evaluation of a smartphone-based system that may assist low SES populations improve their snacking habits. The system has four basic functionalities that did not change after the usability test and the user study, thus demonstrating functions that can be considered essential for a dietary management system: a way to record snacks, monitor personal snacking, monitor family snacking, and gain access to recommendations. From both the usability tests and the user study, it became apparent that visual layout (button and dropdown menu spacing, coloring, minimal text) and feedback (how the user's snacking choices are affecting their health, etc) are the two greatest usability and user comprehension challenges.

In the future, we would like to include a more graphical representation of the impact of the snacking on the user, and possibly a further breakdown of the nutritional content of the snacks to help deepen snack impact comprehension. This design would ideally be evaluated with another user study that recruited low SES population members.

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