A Comparison of User Preferences and Reported Compliance with the Bite Counter and the 24-Hour Dietary Recall

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With two-thirds of the U.S. population being either overweight or obese, accurate tools for self-monitoring eating behaviors are needed for both research and personal purposes. To increase user compliance, these tools should be easy to use and impose a minimal burden on the user. The present study compares user preferences and compliance with the Bite Counter, a wrist-worn device designed to monitor eating behavior by counting bites, to the Internet-based Automated Self-Administered 24-hour dietary recall (ASA24). Eighty-three participants used the Bite Counter and the ASA24 for two weeks. At the end of the two-week period, participants were asked to rate their preference, compliance, and the ease of use for the two tools. 76% of the participants preferred the Bite Counter to the ASA24. Participants consistently used both tools. The Bite Counter was significantly easier to use, according to subjective ratings. These results indicate that users may be more likely to use the Bite Counter consistently than 24-hour dietary recalls.

INTRODUCTION

The prevalence of obesity in the United States has reached the point of becoming a national epidemic. The most recent annual National Health and Nutrition Examination Survey report shows that two-thirds of the population is classified as either overweight or obese (Flegal, Carroll, Ogden, & Curtin, 2010). Self-monitoring is a critical aspect of both obesity research and successful behavioral treatment of obesity.

While energy (caloric) intake (EI) can be easily and objectively monitored in a laboratory setting using direct observation, monitoring EI in the field poses a challenge. There are a variety of tools available to researchers for the purpose of monitoring EI in a field setting, each with its own strengths and weaknesses. The most accurate method available, the Doubly Labeled Water method, can measure EI to within 2% to 8%, but is extremely costly and impractical for use in studies with a large sample size (Schoeller, 1988; Black & Cole, 2000). Many researchers fall back on one of three subjective self-monitoring tools: the food frequency questionnaire, the 24-hour dietary recall, and the food diary.

The food-frequency questionnaire gathers data on general eating habits over long periods of time. It is cheap, easy to use, and has been used in studies with extremely large sample sizes. However, it is incapable of gathering meal-level data and determining EI over short (single-day) periods of time (Subar et al., 2003). 24-hour dietary recalls can be used to estimate daily and meal-level intake. These are more costly and cumbersome than food-frequency questionnaires. Lastly, food diaries can be used to record all meals and analyzed by trained nutrition analysts, but are even more cumbersome than 24-hour dietary recalls, showing lower compliance (Lansky & Brownell, 1982)

The consistent and frequent self-monitoring of energy intake is also one of the most critical components of behavioral interventions for the treatment of obesity (Burke et al., 2009). Numerous studies have found that compliance with the use of self-monitoring tools, such as food diaries, contributes significantly to weight loss (Baker & Kirschenbaum, 1998; Burke et al., 2008; Helsel et al., 2007). The principles of Human Factors can be applied to these tools to increase their usability, and subsequently compliance. Despite this potential role for Human Factors in the behavioral treatment for obesity, very little research has been done to investigate the role of tool usability in subject compliance to behavioral interventions.

Our lab has developed a new tool to be used for the self-monitoring of eating behavior called the Bite Counter, capable of detecting bites of food with a sensitivity of 94% in a controlled setting and 86% in an uncontrolled setting (Dong, Hoover, Scisco, & Muth, 2012). The device is worn on the wrist and detects a wrist-roll motion that is characteristic of taking a bite of food. It is designed to be unobtrusive and easy to use, so that users will wear it for every meal, and in doing so reduce their overall energy intake.

The purpose of the present study was to compare user preferences and compliance between the Bite Counter and the ASA24, a computerized, automated, web-based 24-hour dietary recall. It was hypothesized that users would subjectively prefer the Bite Counter over the ASA24 and that they would report recording more meal data with the Bite Counter than the ASA24.

METHODS

Participants

Participants were 83 men and women (43 females) recruited via flyers and broadcast e-mails from Clemson University and the surrounding area. Participants ranged in age from 18 to 66 (mean = 33.7). Participants were paid $50 and received a data summary for participation in the study.

Materials

Bite Counter. The Bite Counter detects a wrist-roll motion that is characteristic of taking a bite of food. The version of the device that was used for this study resembles a watch, with a digital display, an on/off button, and a display cycle button (see Figure 1). When bite count mode is off, the device displays the time. For the purposes of this study, bite count feedback was disabled. When the device was in bite count mode, it only displayed the word "On."

Figure 1. The Bite Counter.

ASA24. The ASA24 (Version 1 (2011), Bethesda, MD, National Cancer Institute) is an automated, self-administered 24-hour dietary recall that can be completed from an Internet-connected computer (Zimmerman, T., et al., 2009). Participants complete the ASA24 once every 24 hours, and are asked to recall all food items that they consumed over the previous day. Foods were selected from a searchable database, and portion sizes were estimated with portion size descriptions and associated food pictures (see figure 2). Participants were automatically e-mailed reminders to complete the ASA24 daily.

Usability Questionnaire. Usability data was gathered via experimenter generated questions, and included questions about self-monitoring tool preference (Did you prefer the Bite Counter or the ASA24?), ease of use, frequency of use, and liking or disliking for each tool.

Procedure

Prior to beginning the study, participants completed an online pre-screening questionnaire. Participants were excluded if they had an eating disorder history and/or did not have daily access to an Internet-connected computer. Upon passing the initial pre-screening, participants were brought into a laboratory setting where they completed the Clemson University Institution Review Board Consent form. They were then given the instructions for the procedure and issued a bite-counter.
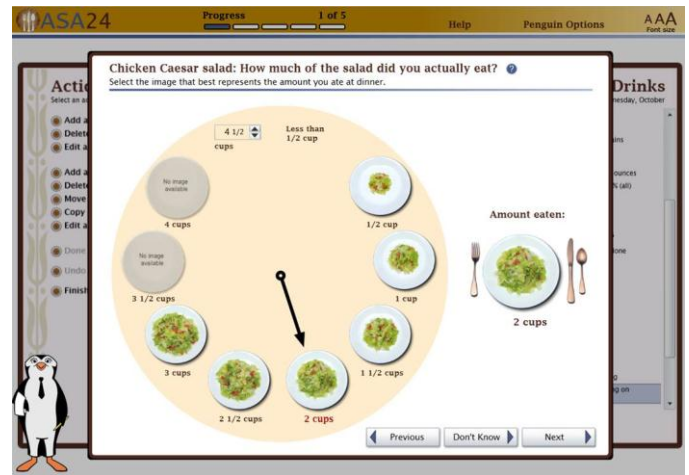

Figure 2. Portion size estimation in the ASA-24

Participants were instructed to use the tools for a total of two weeks. Over the course of those two weeks, they were asked to wear the Bite Counter from morning to evening and activated it each time they ate a meal or a snack. They were also asked to complete the ASA24 every day, inputting each food item that they consumed on the previous day. Participants were encouraged to use a food diary to keep track of their meals, but this was not a requirement. Upon completion of the two week period, participants returned to the lab for debriefing and to return the Bite Counter and complete the usability questionnaire.

RESULTS

Usability Data for the ASA24

Table 1 shows the frequency of responses for questions about the ASA24 dietary recall program. In associated open-ended responses, participants with a favorable view of ASA24 described the interface in several ways, including: simple, straight-forward, well-organized, user friendly, and easy to follow. They liked the "comprehensive" list of food choices, the food categories, the search feature, the "good layout", the pictures of the foods, being able to add forgotten foods at any time, the prompting pathway of questions, being able to see the meal breakdown and summary, its presence on the Internet and being able to use a computer to complete it, the instructions provided, and the e-mail reminders with links. Participants described that the ASA24 became routine, that it was easy to complete if they were already tracking their meals, and that writing things down during the day made it easier to complete. Participants liked seeing what they ate and how much, explaining that it held them accountable and increased their awareness of behaviors like snacking and their overall intake patterns.

Participants also described why the ASA24 was difficult to complete, what they disliked about the program, and problems they had with the website. Some found it difficult to remember meal details, such as specific foods, portion sizes, and the time at which the meal was eaten. Many participants expressed a desire for a "favorites" option, being able to save

commonly eaten foods for quick entry. They sometimes had trouble finding foods, especially if the food was international cuisine, and thought that some options were incomplete or unclear. Many participants described frustration with the penguin interviewer providing instructions and slowing down the recall process. When ASA24 was initially released, the penguin would provide instructions for every recall. About halfway through data collection (December 28, 2011), ASA24 was updated so that participants were asked on their second and all subsequent recalls if they wanted the penguin's help or if they wanted to turn him off. This appeared to eliminate frustration with the penguin. Participants described the interface as "unwieldy" and "not stream-lined" with too much mouse clicking and not enough opportunity to use the keyboard. Needing Internet access was sometimes troublesome, and sometimes the program would slow down or freeze, which was the source of many of the reported problems with ASA24. Participants who wanted to use Apple products (e.g., iPhone, iPad) or the Linux operating system were disappointed to learn that ASA24 was not compatible. Downloading the new version of Microsoft Silverlight was difficult for some participants, but this problem was always resolved through troubleshooting. Finding the time to complete the recall was difficult for participants with busy schedules. Some participants wanted to enter the meals during the day instead of all at once the following day.

Table 1: Responses to usability questions about the ASA24 dietary recall.

Question	N	% of total sample
Frequency of completing ASA24		
For every food and beverage	18	21.7
For most foods and beverages	56	67.5
For main meals and beverages	3	3.6
Forgot some meals and beverages	2	2.4
Forgot one or more days	4	4.8
Ease or difficulty of use		
Extremely easy	5	6.0
Very easy	22	26.5
Somewhat easy	30	36.1
Neither easy nor difficult	13	15.7
Somewhat difficult	10	12.0
Very difficult	3	3.6
Liked or disliked		
Liked very much	10	12.0
Liked somewhat	26	31.3
Neither liked nor disliked	28	33.7
Disliked somewhat	19	22.9
Experienced ASA24 problems		
Yes	28	33.7
No	55	66.3
ASA24 resulted in eating behavior change		
Yes	45	54.2
No	38	45.8
Recorded dietary intake elsewhere		
Yes	49	59.0
No	34	41.0

Usability Data for the Bite Counter

Table 2 shows the frequency of responses for questions about the Bite Counter. Participants found the Bite Counter easy to use because they only had to press a button to turn it on and off. Some people liked that it was on the wrist, easily

portable, functioned as a watch, and could be strapped to a lunch bag or the refrigerator handle. Charging was described as similar to charging a cell phone. They described using the device as "not rocket science, a "no brainer", "user friendly", and that it "became second nature". The audible and visual feedback was helpful for knowing when the device was turned on and off. Some participants liked being asked about the device by friends and coworkers so that they could tell them about their participation in the study. Participants liked that it increased their awareness of eating.

Overall, the most difficult aspect of the Bite Counter was remembering to turn it on and off. Some participants found it harder to remember as they became more accustomed to wearing the Bite Counter, when at social functions, or when engaged in other activities while eating. Some participants had trouble remembering to charge the device at night, and some participants had difficulty remembering to wear the device. The device was also "frustrating" when it would shut off automatically during meals and when the display malfunctioned. It is important to note that a beta version of the device was used during this study and this auto shut-off problem has subsequently been resolved. Participants disliked that it was not waterproof, that it could not be worn during exercise, that it got in the way of long-sleeves and jackets, and that they did not receive bite count or charging feedback from the device. In terms of physical discomfort and appearance, the device was described as unattractive, uncomfortable, "too big", "bulky", "cumbersome", not "trendy", and "ugly". Some participants found the Velcro to be irritating, and some participants disliked having something on their wrist. A few participants wanted a longer wristband so that they could slide their hand through the band without having to separate the two ends. As described above, friends and coworkers often asked about the device, but some participants disliked describing their "weird-looking watch" to others. When asked how the device could be improved, participants suggested a smaller device with a curved back, a thinner non-Velcro wristband, optional beeping, less frequent charging, different colors, additional watch features like the date and a stop watch, syncing to devices like the iPhone, water-resistance, impact-resistance, and automatic detection of eating.

Table 2. Responses to usability questions about the Bite Counter.

Question	N	% of total sample
Frequency of wearing Bite Counter		
All day everyday (from morning to evening)	22	26.5
Only part of the day (more often than meals)	35	42.2
Only during meals, took it off other times	25	30.1
Did not wear it during some meals	1	1.2
Ease or difficulty of use		
Extremely easy	26	31.3
Very easy	38	45.8
Somewhat easy	11	13.3
Neither easy nor difficult	5	6.0
Somewhat difficult	2	2.4
Very difficult	1	1.2
Liked or disliked		
Extremely liked	2	2.4

Liked very much	9	10.8
Liked somewhat	21	25.3
Neither liked nor disliked	38	45.8
Disliked somewhat	12	14.5
Disliked very much	1	1.2
Problems wearing: physical discomfort		
Yes	19	22.9
No	64	77.1
Experienced problems with Bite Counter		
Yes	36	43.4
No	47	56.6
Bite counter changed eating behavior		
Yes	43	51.8
No	40	48.2
Preferred tool		
Bite counter	63	75.9
ASA24 dietary recall	20	24.1

Comparative Usability Data

When asked which tool they preferred, the majority of participants (75.9%) reported preferring the Bite Counter because it took less time, was easier and simpler, and because it was new and different. For those who preferred using the ASA24 dietary recall, they preferred this tool because it allowed them to receive feedback about what foods they were eating and how much they were eating.

The responses for "Liking or Disliking" and "Ease or Difficulty of Use" were converted to 7 point scales and compared using paired sample t-tests. For the "Liking or Disliking" scale, "Extremely Disliked" was coded as a 0 and "Extremely Liked" was coded as a 6. Likewise, for the "Ease or Difficulty of Use" scale, "Extremely Difficult" was coded as a 0 and "Extremely Easy" was coded as a 6. Participants did not like the Bite Counter better than the ASA24 ($t(82) = -.43$, $p > .05$). However, the Bite Counter was rated as significantly easier to use than the ASA24 ($t(82) = -7.65$, $p < .05$).

Participants were compliant with both tools. 92.8% of participants reported recording *at least* main meals and beverages with the ASA24. 98.8% of participants reported using the Bite Counter to record *at least* main meals and beverages.

DISCUSSION

These results indicate that overall, participants preferred to use the Bite Counter over the ASA24, citing its simplicity and ease of use. Many of the problems that participants listed with the Bite Counter were largely aesthetic or due to technical problems, rather than with using the device itself. While compliance was high for both tools in this study, user preference may lead to higher compliance in personal use and diet adherence.

The present study has a few limitations. First, compliance in this study cannot be generalized to compliance within a behavioral intervention or a personal attempt at weight loss, although 43% of the study participants were trying to lose weight. Second, the usability data gathered was largely self-report. Future studies should focus on objectively comparing the usability of multiple self-monitoring tools within a behavioral intervention.

The user acceptance of self-monitoring tools carries broad implications, and the principles of Human Factors should be applied to them. If a self-monitoring tool is unobtrusive and easy to use, then users will be more likely to use the tool effectively and routinely. If such a tool can be shown to be accurate as well, then it can be used to improve the success of behavioral interventions and help combat the obesity epidemic. Future studies should conduct a more thorough usability evaluation of a wider variety of tools for self-monitoring, and further examine relationships between tool usability, compliance, and weight loss.

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