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Automated Interventions for Multiple Health Behaviors Using Conversational Agents

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Abstract

Objective—An automated health counselor agent was designed to promote both physical activity and fruit and vegetable consumption through a series of simulated conversations with users on their home computers.

Methods—The agent was evaluated in a 4-arm randomized trial of a two-month daily contact intervention comparing: a) physical activity; b) fruit and vegetable consumption; c) both interventions; and d) a non-intervention control. Physical activity was assessed using daily pedometer steps. Daily servings of fruit and vegetables was assessed using the NIH/NCI self-report Fruit and Vegetable Scan.

Results—Participants in the physical activity intervention increased their walking on average compared to the control group, while those in the fruit and vegetable intervention and combined intervention decreased walking. Participants in the fruit and vegetable intervention group consumed significantly more servings per day compared to those in the control group, and those in the combined intervention reported consuming more compared to those in the control group.

Conclusion—Automated health intervention software designed for efficient re-use is effective at changing health behavior.

Practice Implications—Automated health behavior change interventions can be designed to facilitate translation and adaptation across multiple behaviors.

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I confirm all patient/personal identifiers have been removed or disguised so the patient/person(s) described are not identifiable and cannot be identified through the details of the story.

Conflict of interest

The authors have no conflicts of interest that could influence this work.

Keywords

relational agent; embodied conversational agent; behavioral informatics; dialogue system; health behavior change intervention; physical activity promotion; walking promotion; diet promotion; fruit and vegetable consumption promotion; ontology

1 Introduction

Behavioral health problems rarely occur in isolation. Managing chronic conditions such as diabetes, prevention of conditions such as cancers, and addressing overweight and obesity, all require constellations of behaviors to be modified in parallel. To date, most automated health behavior change interventions are designed to only address a single behavior. One barrier to implementation of multi-behavior change interventions is simply the increased scope and complexity of building the individual interventions at the same time. The complexity of design and test of such automated systems increases exponentially with the number of behaviors targeted, since users may have any combination of the conditions addressed.

We have undertaken the development of a health behavior change counseling dialogue system that models the theory-driven therapeutic planning processes of a human health advisor during a counseling session. Importantly, the software is designed to be re-usable, so that new or derivative interventions can be implemented with minimal effort, thus facilitating the design of multi-behavior change interventions [1]. Re-use is facilitated by representing knowledge about health behavior change theory, constructs, and atomic intervention actions in a computational ontology. An ontology is a taxonomic description of the concepts in an application domain and the relationships among them. In addition to facilitating re-use, computational ontologies also provide a formalism that can facilitate clarification and description of the fundamental concepts in a domain through consensus of experts and can facilitate interchange of information among diverse systems by describing, at various levels of detail, the kinds of data entities that can be exchanged, independent of the particular names the entities are given in each system.

We have tested this approach by implementing automated interventions for physical activity and fruit and vegetable consumption. Participation in moderate amounts of physical activity has important health benefits, including beneficial effects on risk factors for disease, disability, and mortality [2–6], yet a substantial proportion of the U.S. adult population remain underactive or sedentary [2]. Fruit and vegetable consumption plays a protective role in a large number of epithelial cancers [7,8], and is associated with reduced risk for heart disease, stroke, and hypertension [9–15], yet only 23% of American adults meet the (year 2000) recommendation to consume five or more servings of fruit and vegetables per day [16,17].

The interventions we implemented are eclectic, based on elements from the transtheoretical model, motivational interviewing, and social cognitive theory [1,18–21]. There are several approaches to targeting multiple behaviors in one intervention. The behaviors can be targeted in sequence, moving from one to the next once a completion criterion is reached (e.g., this could be a target stage of change, a specified time duration, or a specified number of user-system interactions, after which the system's educational content is exhausted). The behaviors can also be targeted in parallel, with all or some behaviors addressed in every interaction, or addressed in alternating interactions over time. Our approach roughly follows the latter one: following a few introductory conversations, the agent alternates topics so that it focuses a conversation on physical activity counseling on one day, then focuses on diet counseling the next, then repeats the sequence through the end of the intervention. However, even when one behavior is focused on for counseling (e.g., involving problem solving, homework assignment or education), a brief discussion of the other behavior was provided, involving review of progress and re-negotiation of short-term behavioral goals. Further, when users were in the contemplation stage of change the system spent additional sessions focusing on the target behavior, under the assumption that this was needed to help them get started on goal-setting program.

1.1 Intervention Design

The knowledge ("Artificial Intelligence") in the system is encoded using two fundamentally different representations: declarative facts about the world and procedures the agent can follow during its dialog with users.

Declarative facts are themselves represented in two fundamentally different ways: epistemological knowledge about the kinds of things in the world that the agent can reason about—represented in the ontology (using OWL [22])—and specific facts about the specific behavior change theories and techniques the agent can use, and about a particular user the agent is talking to (using RDF [23]). The ontology encodes dictionary-like knowledge, such as the fact that the "Actions" the agent can take can be either "Therapeutic Actions" or "Non-therapeutic Actions" (such as saying "Hello!" to the user), and that the Therapeutic Actions available to the agent include "Therapeutic Dialog Actions" (talk therapy) and "Homework Actions" (homework assignments the user is asked to do outside of the agent counseling sessions). Examples of specific facts would be that asking the user to "Try looking for information about exercise in newspapers and magazines." is an example of a Homework Action for physical activity promotion, that this action is appropriate for users in the Contemplation stage of change, and that the specific user the agent is talking to right now is in Contemplation.

Procedural knowledge is encoded in a hierarchical task decomposition language (CEA-2018 [24]), that is based on a theory of the structure of dialog [25]. CEA2018 represents agent goals, and actions that the agent and the user can take during a given dialog, and various relationships that hold among these entities. For example, initial goals of the agent may be to hold a counseling dialog with a user with the intention of increasing a health behavior. This goal can be matched to a "recipe" that describes one way the agent can satisfy the goal, for example by initiating a dialog, greeting the user, conducting some "small talk", conducting the core part of the behavior change counseling, saying farewell to the user, and terminating the conversation, in that order. Each of these steps can give rise to more refined goals that are matched to other recipes. For example, the core counseling dialog for a user in the Action stage of change may consist of reviewing their progress since the last conversation, conducting a problem solving dialog about specific barriers to change, and setting goals as a new homework assignment. Ultimately, the actions in the most refined recipes will consist of specific things the agent and user can say in the conversation.

Note that much of the structure of a counseling conversation, and much of the declarative knowledge, required by a counseling agent can be described independent of a specific behavior. The above examples work for either physical activity or fruit and vegetable promotion.

The declarative and procedural knowledge is interpreted and turned into an interactive conversation for a particular user by a dialog interpreter (DTask [26]). Together, the ontology and the procedural knowledge are a unique new set of AI methods for organizing how an agent can counsel a user for a series of health behavior change conversations. Figure 1 shows an excerpt of a conversation generated using this approach.

During the development of our intervention we first designed and implemented the physical activity promotion part of the system, then extended it to also promote fruit and vegetable consumption. Through the use of the knowledge representations described above we were able to build the second system re-using 98% of the actions, 98% of the recipes, and 14% of the agent utterances, representing 22% re-use by source lines of code. The second system was built in 9% of the calendar time and 4% of the person hours required to develop the initial exercise promotion system [1].

1.2 Evaluation Study

In the rest of this paper, we describe the results of a randomized pilot study designed to provide preliminary evaluation of three behavioral interventions developed using the approach described above. We have used the ontology-based design approach to develop an animated conversational agent that plays the role of a health counselor that can promote both physical activity (ACT) and fruit and vegetable consumption (DIET) through a series of simulated conversations with users on their home computers (Figure 2). This approach and agent were evaluated in a 4-arm randomized trial of a two-month daily contact intervention comparing: a) ACT; b) DIET; c) ACT+DIET (both interventions); and d) CONTROL (a control group provided only with pedometers for tracking physical activity). The behavioral goal of the ACT system is to motivate sedentary subjects to perform the minimum recommended amount of physical activity: 30 minutes per day of moderate or greater activity [27,28]. The behavioral goal of the DIET system is to motivate subjects who are not regularly eating at least 4-1/2 cups of fruits and vegetables a day to reach this level [28]. The goal of the ACT+DIET system is to achieve both behavioral goals.

The pilot study has the following hypotheses.

- H1. Subjects receiving ACT will significantly increase their physical activity (PA) behavior, compared to non-intervention CONTROL subjects.
- H2. Subjects receiving DIET will significantly increase their intake of fruits and vegetables compared to non-intervention CONTROL subjects.
- H3. Subjects receiving ACT+DIET will significantly increase their PA behavior compared to non-intervention CONTROL subjects.
- H4. Subjects receiving ACT+DIET will significantly increase their intake of fruits and vegetables compared to non-intervention CONTROL subjects.

2 Methods

Subjects in the intervention groups accessed the system remotely over the Internet from their home computers on a daily basis during the two-month intervention period. Demographics and baseline values for outcome measures were collected at the start of the intervention period (T_0); outcome measures were assessed a second time, along with usability assessments and semi-structured interviews, at the end of the intervention period (T_1). All participants were provided with pedometers and instructed to wear them daily and upload their steps to a server on a weekly basis.

The study was approved by the Northeastern University IRB, and study participants were compensated a fixed amount.

2.1 Measures

Physical activity was assessed at T_0 and T_1 using the International Physical Activity Questionnaire (IPAQ), which has been validated in several prior studies[29,30]. Steps walked was objectively assessed using Omron HJ-720ITC pedometers given to all study participants. While the pedometer assess walking specifically, the IPAQ assesses overall physical activity. Servings of fruit and vegetables were assessed at T_0 and T_1 using the NIH/NCI Fruit and Vegetable Scan (FVS) [31]. The FVS is a ten-item instrument that includes assessment of portion size.

Participants were weighed at T_0 and T_1 using a calibrated scale.

Satisfaction was assessed via three single scale measure items (Table 4).

2.2 Recruitment & Eligibility

Subjects were recruited from an online job posting site. Eligibility criteria for this study included: 1) age 18 or older; 2) have a home computer with Internet connection; 3) are able to walk unaided; 4) understand spoken and written English; and 5) are in Precontemplation or Contemplation Stages of Change with respect to both (a) the current DHHS/ACSM guidelines for PA (30 minutes a day of moderate-or-greater intensity PA on five or more days per week) [27,32]; and (b) current DHHS guidelines for daily consumption of fruits and vegetables (4-1/2 cups a day)[28]. Exclusionary criteria include: 1) have a medical condition that would make increasing PA level a health risk, assessed using the PA Readiness Questionnaire (PAR-Q)[33]; 2) are on a prescribed diet; and 3) have any other member of the household enrolled in the study.

2.3 Procedure

Following screening, consent, and baseline measurements in our laboratory, participants were provided with software to install on their home computer and given a brief tutorial on its use. Participants in the CONTROL group used their software only to upload their pedometer steps; participants in all other groups were also instructed how to interact with the conversational agent, and asked to conduct one conversation per day with the agent at home. All participants were provided with pedometers and instructed in their use. Following this, individuals participated in the study from home for the next two months. At the end of this time, participants returned to our laboratory to collect final outcome measures and engage in a semi-structured interview about their experience.

3 Results

One hundred and twenty-two (122) participants were enrolled into the study and randomized among the four study arms, of which 113 (93%) completed the final two-month T1 assessment. Figure 3 shows the flow of participants in the study.

Table 1 shows baseline demographics of study participants, contrasting those in each arm of the study. Overall, participants ranged in age from 21 to 69 years old (mean 33.0 +/− 12.6) were 61% female, predominately white (52%) and Asian (33%), single and had some college education. Body mass index (BMI) ranged from 18.8 to 46.4 (mean 27.8).

3.1 Longitudinal Analysis of Daily Pedometer Steps

Figure 4 shows pedometer steps by study participants, averaged per 15 day interval, by study group. We assume that any day in which less than 100 steps are recorded means that the participant did not wear the pedometer. We treat the step counts for this day as missing data. We fit a mixed-effect model including effect of study day (time), study condition, and an interaction. This model assumes a simple linear trend: the main effect of condition is the difference in intercepts between conditions, while the interaction is the difference in slopes. We assume here that the differences between groups in the first time period is a result of differences in baseline walking behavior between the groups prior to the start of the study (e.g., the effects of poor randomization), and thus we focus our analysis on significant changes in step counts over the duration of the study. A series of likelihood-ratio tests against reduced models indicates that the interaction effect is significant, but neither main effect is significant. The full model is shown in Table 2. Results indicate that the ACT group increases their daily walking faster than CONTROL, but the DIET group is slower, and the ACT+DIET group is somewhere in the middle. Thus, there is some evidence that multiple interventions might interfere with each other.

3.2 International Physical Activity Questionnaire (IPAQ)

The IPAQ data is highly skewed, and is transformed (Yeo-Johnson transformation) prior to analysis. A one-way ANOVA was used with the transformed IPAQ scores as the dependent variable, and study condition as the independent variable. There are no significant differences among conditions, $F(3,107)=1.07$, $p=0.367$.

3.3 Fruit & Vegetable Consumption (FVS)

Figure 5 shows mean change in FVS scores (T1 – T0) by study condition.

Model selection indicated that the simplest model is best, in which baseline FVS alone is used as a covariate in an ANCOVA, with final FVS as the dependent measure and study condition as the independent variable (Table 3). Results show a significant difference by condition, $F(3,103)=4.52$, $p=0.005$, with the DIET intervention doing the best. A Tukey post-hoc analysis indicates that the only significant pairwise difference, adjusting for multiple comparisons, is DIET vs. CONTROL, with ACT+DIET vs. CONTROL near significant.

3.4 Weight

Weight changed little for participants over the two months of the study, with no significant differences among groups, $F(3,105)=1.09$, $p=0.374$.

3.5 Satisfaction

Self-report satisfaction scores are shown in Table 4. There were no significant differences among the three intervention groups on these measures.

3.6 Qualitative Results

Semi-structured interviews were conducted with 20 participants from the ACT, DIET, and ACT+DIET groups. Participant responses to semi-structured interview questions were transcribed from the videotape and common themes were identified [34].

When asked what they like best about the agent Karen (the conversational agent in Figure 2), 7 people (35%) said that they like Karen because she was nice, personal, and was someone they could relate to, and four people (20%) said that they liked how Karen would show them their progress with the steps chart every time they had a conversation with her. Four people (20%) said that they like Karen because she would not discipline them if they did not meet a goal or log onto the system, while three people said that they liked being held accountable by Karen.

When asked if the agent helped them to achieve their goals, 10 people (50%) agreed that the agent did help (e.g., “I think it moved me closer to eating better. I am more motivated and I am thinking more about trying to get 5 servings of fruits and veggies every day.”). Four people (20%) said they believed it was a combination of using the pedometer and talking to

Karen that helped them reach their goals. When asked what about the agent helped them the most, 3 people said that the constant reminder by Karen was what helped them the most.

4 Discussion and Conclusion

Overall, the four study hypotheses received mixed support. The first hypothesis (H1), that subjects receiving ACT will significantly increase their PA, compared to non-intervention CONTROL subjects, received partial support. Based on analysis of pedometer steps, participants in the ACT group tended to increase their daily walking faster than CONTROL. However, there were no significant differences in physical activity based on self-report IPAQ scores.

The second hypothesis (H2), that subjects receiving DIET will significantly increase their intake of fruits and vegetables compared to non-intervention CONTROL subjects, received strong support through significant increase in fruit and vegetable consumption (as measured by the FVS) for the DIET group compared to CONTROL. The hypothesis that subjects receiving ACT+DIET will significantly increase their PA behavior compared to non-intervention CONTROL subjects (H3), received no support, based on either analysis of pedometer steps or IPAQ scores. The final hypothesis (H4), that subjects receiving ACT +DIET will significantly increase their intake of fruits and vegetables compared to non-intervention CONTROL subjects, received marginal support: differences between ACT +DIET and CONTROL participants on FVS scores were in the hypothesized direction and trending towards significance.

4.1 Discussion

The evaluation study demonstrated that, while the individual health behavior change interventions performed as expected—with ACT resulting in superior walking behavior and DIET resulting in improved fruit and vegetable consumption, both relative to a non-intervention control group—the combined, multi-behavior change intervention did not result in significant improvements relative to controls. There are several possible reasons for this. One possible explanation is that our approach to intervening on multiple behaviors is to alternate which behavior was discussed on sequential logins, thus participants in the ACT +DIET group received half the number of physical activity counseling sessions as those in ACT and half the number of diet counseling sessions as those in DIET. Another possibility is that the two interventions actually interfered with each other, either on a psychological level (e.g., through distraction) or an instrumental level (e.g., taking more time to shop for and prepare fruit and vegetable dishes may have decreased time available for physical activity). Another explanation is that the combined intervention simply had smaller effect sizes compared to the individual behavior interventions, requiring more participants to reach significance. The trends in Figure 4 may also imply that the PA intervention was simply most effective for sedentary individuals (those with the lowest baseline step counts).

We have begun exploring solutions to address the problem of perceived repetitiveness mentioned by several participants [35]. In one study, we confirmed that simply increasing superficial linguistic and graphical variability during daily health behavior change counseling sessions with an automated coach agent leads to greater self-reported desire to continue using the system, as well as a significant increase in actual system usage. In a second study we demonstrated that having the coach agent tell personal “backstories” about its personal history (as if it were a person) led to significant increases in system usage compared to an identical agent that told the same stories as if they were about another user, demonstrating that users were more engaged by a more anthropomorphic agent.

Limitations of our study include the generalizability of our findings, especially given the very small convenience sample used and the relatively short duration of the intervention. We also acknowledge that our CONTROL group does not represent a true non-intervention control, since providing individuals with pedometers alone has been shown to result in increased physical activity. However, this should make any significant physical activity results stronger. Finally, we cannot determine whether the differences between groups during the first 15 days of the study were due to baseline differences or initial reactions to the study conditions, since we did not measure true pre-intervention baseline behavior.

4.2 Conclusion

Together with our earlier pilot study [1], we have demonstrated that automated health interventions can be developed using software representations that promote reuse, that the representations do indeed lend themselves to reuse, and that this approach results in interventions that are effective at changing health behavior.

4.3 Practice Implications

Adapting a computerized behavioral intervention developed for a research study (or for a different application) for large-scale deployment by an institution or public health department typically requires significant modifications to the original system, and these modifications often represent an insurmountable barrier to dissemination [36]. The use of open source software, designed using public standards and computational ontologies, with re-use in mind, significantly lowers the cost and complexity of adapting these systems for practice.

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A: Hi Elissa. Nice to see you again! *GREETING*

U: Hello.

A: How are you doing today? *SMALL TALK*

…

A: So, Elissa, I would like to ask you a few questions about diet. *ASSESSMENT*

U: OK.

A: On a scale from 0 to 10, how motivated are you to eat more fruits and vegetables?

U: 3 or 4

…

A: In what ways does your diet concern you? *TALK THERAPY*

U: I worry about my health.

A: It sounds like you are saying that your health is not the best, because of the way you eat.

U: Yes, I am concerned about being sick.

…

A: Is it OK if I suggest some homework for you to do. Just something simple to help you start thinking about different things you can do to help you achieve your diet goals. *HOMEWORK*

U: OK

A: If you see another person eating fruits and vegetables in a new way that looks appetizing don't be afraid to ask them how they did it. Most people will be willing to share their yummy secrets.

U: Okay.

A: So Elissa, how about trying this before the next time we talk?

U: I could do that.

…

A: Well, that's everything for today. *FAREWELL*

A: So, when will I see you again?

U: In a few days

A: Okay, take care.

A: Goodbye Elissa.

U: Bye Karen.

Figure 1.

Sample Excerpt of User-Agent Counseling Dialog (‘A’ precedes agent utterances; ‘U’ precedes user utterances).

NIH-PA Author Manuscript

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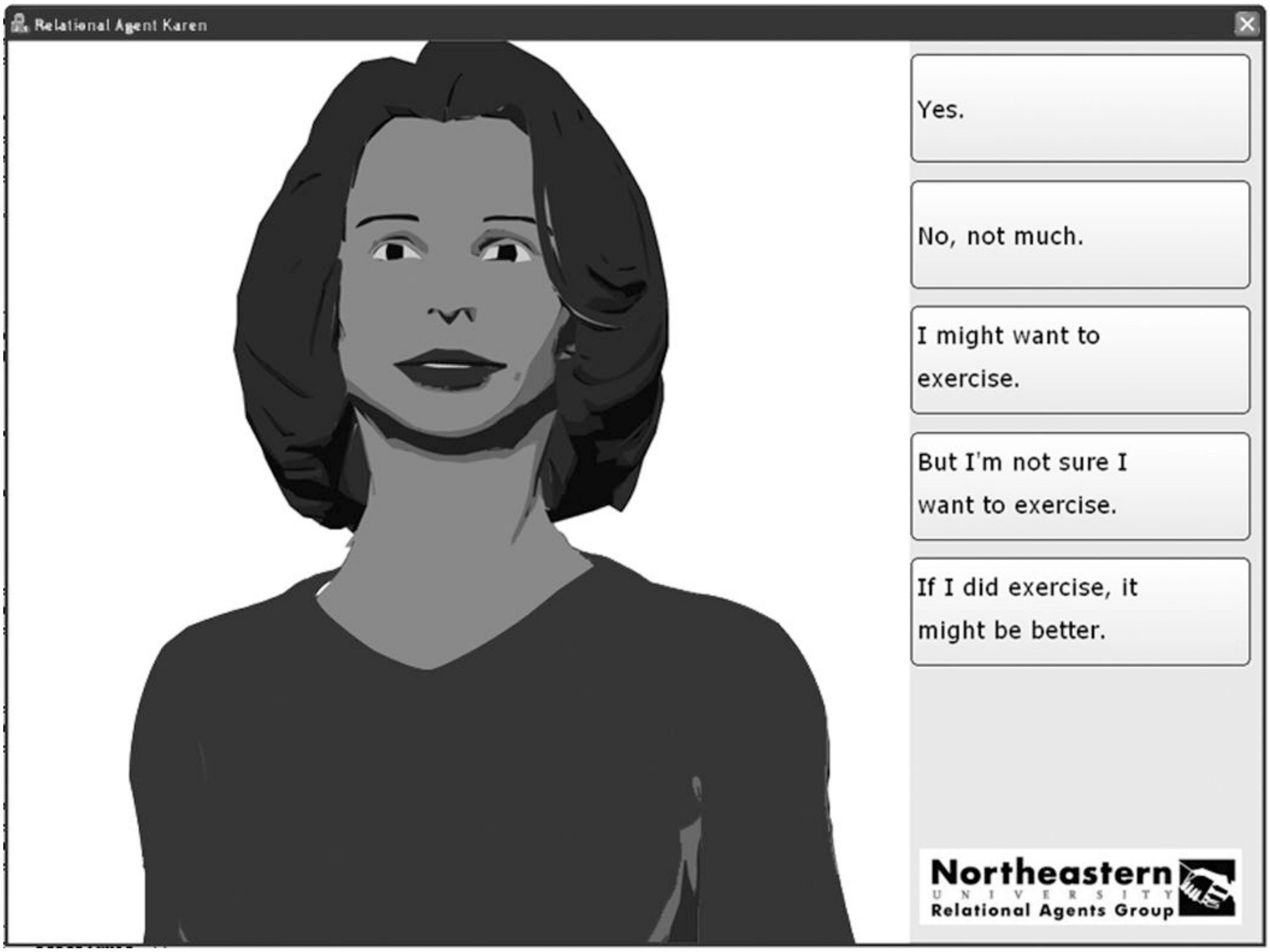

Figure 2.
Conversational Agent User Interface

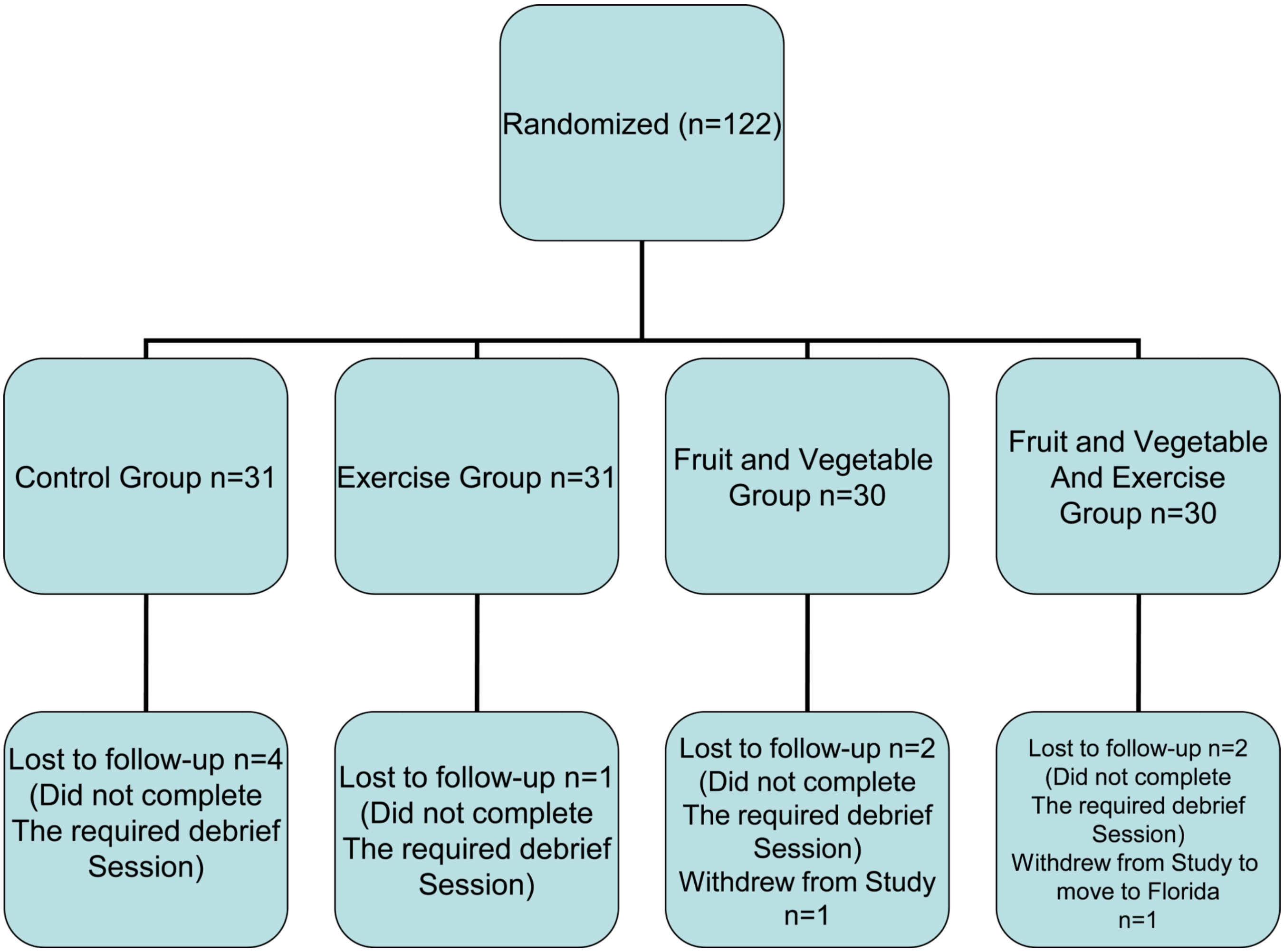

Figure 3.
Patient Flow in Study (Consort Diagram)

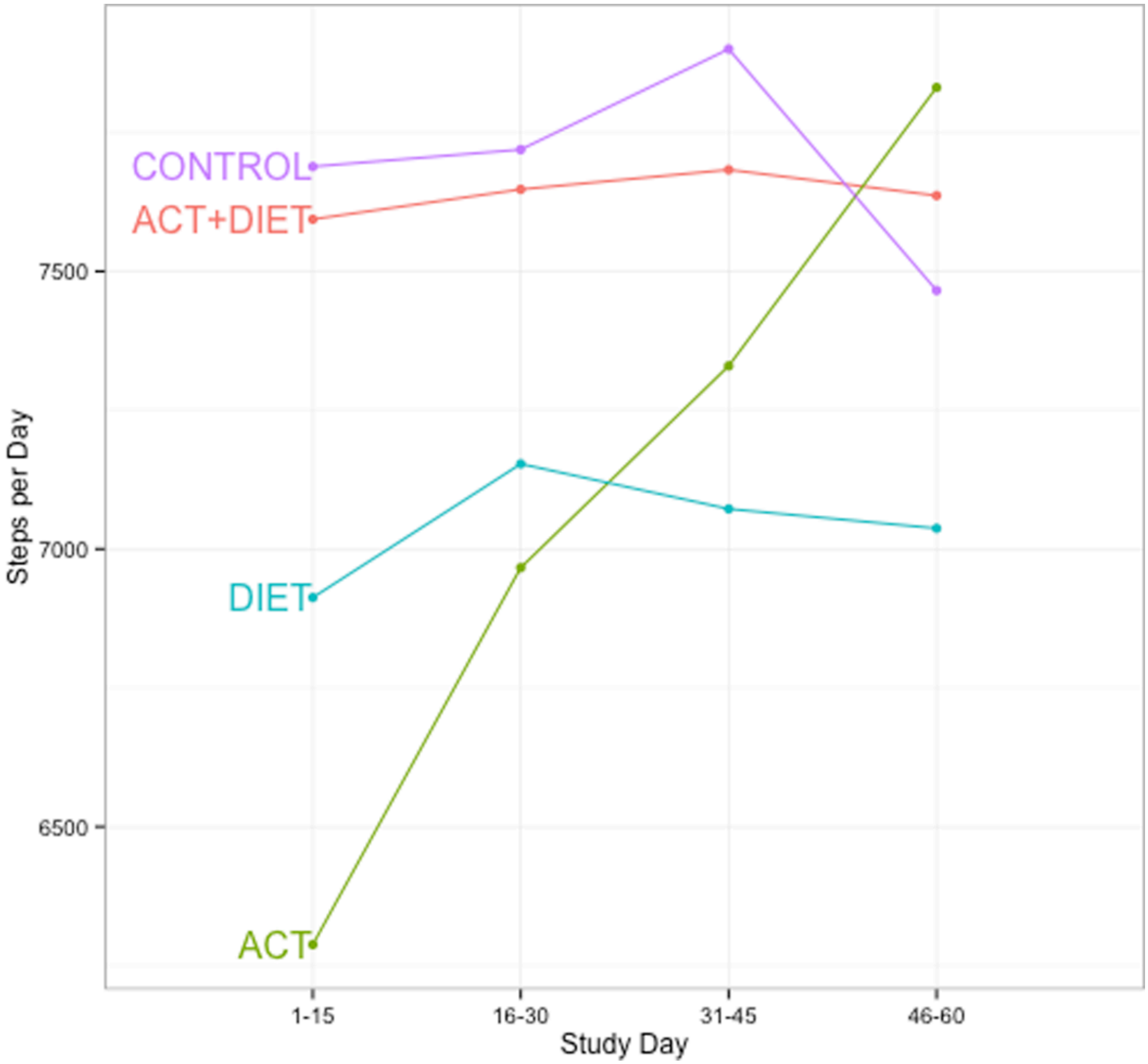

Figure 4.
Pedometer Steps by Study Group

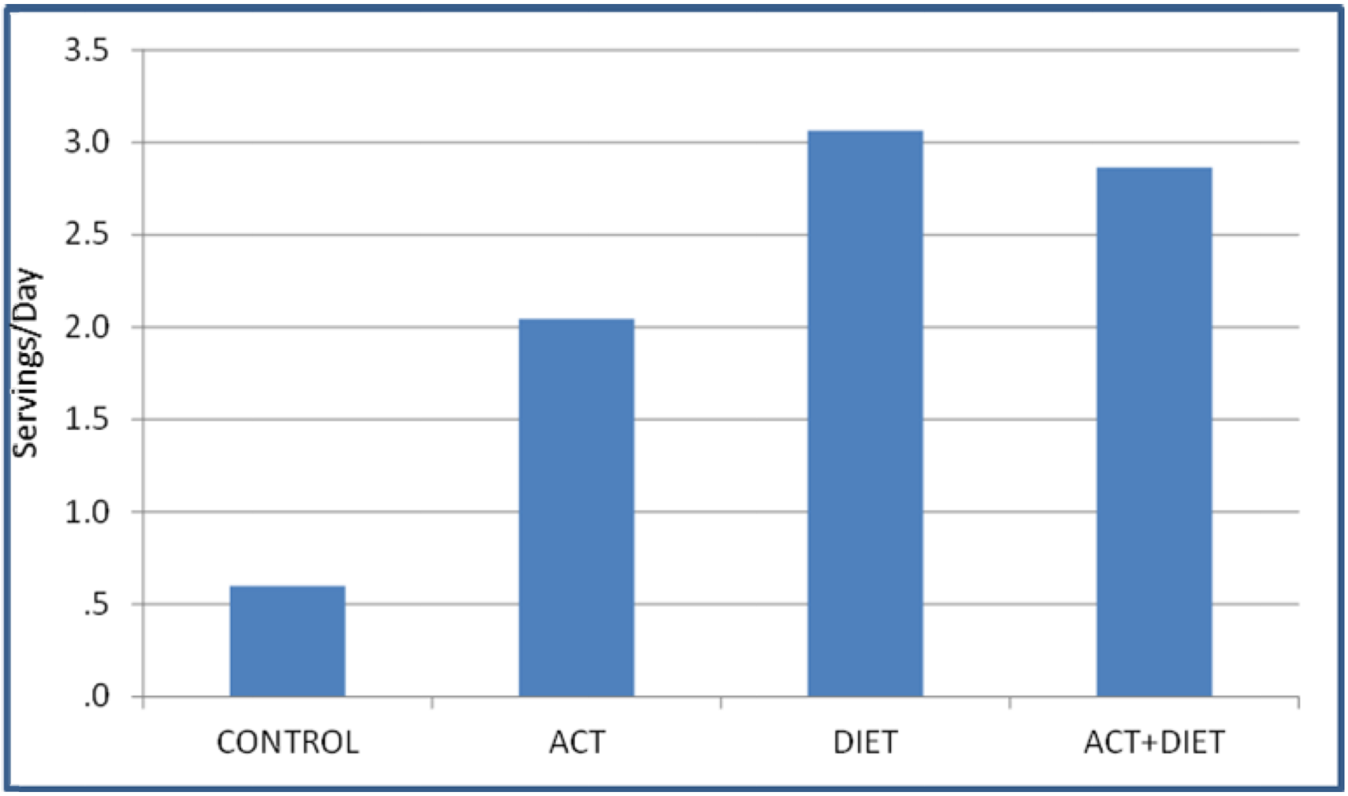

Figure 5.
Fruit & Vegetable Consumption by Study Condition

Table 1

Baseline demographics and stage of change for study participants, reported as Mean (SD) for age, BMI, and SF-12, and as Count (% of Total) for all others. Reported p-values are tests of significant baseline differences across conditions, by one-way ANOVA (age, BMI, SF-12) or by chi-square test of independence (all others).

	All	CONTROL	ACT	DIET	ACT+DIET	p
Age	33.0 (12.6)	32.0 (14.5)	33.5 (12.8)	32.9 (11.1)	32.4 (12.3)	.813
Gender						.349
Male	48 (39.3%)	12 (38.7%)	15 (48.3%)	13 (43.3%)	8 (26.6%)	
Female	74 (60.7%)	19 (61.3%)	16 (51.6%)	17 (56.6%)	22 (73.3%)	
Race						.835
Am. Indian	1 (0.8%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Asian	40 (32.7%)	10 (32.2%)	7 (22.5%)	12 (40.0%)	11 (35.0%)	
Black	10 (8.0%)	1 (3.2%)	3 (9.6%)	3 (10.0%)	3 (10.0%)	
White	63 (51.6%)	17 (54.8%)	18 (58.0%)	14 (46.6%)	14 (46.6%)	
Education						.769
High School	2 (1.6%)	1 (3.2%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	
Tech/Voc.	3 (2.4%)	0 (0.0%)	1 (3.2%)	1 (3.3%)	1 (3.3%)	
Some College	27 (22.1%)	7 (22.5%)	10 (32.2%)	4 (13.3%)	6 (20.0%)	
College Grad.	66 (54.0%)	19 (61.2%)	13 (42.9%)	17 (56.6%)	17 (56.6%)	
Comp. Experience						.833
Rarely	2 (1.6%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	1 (3.3%)	
Regular User	88 (72.1%)	23 (74.1%)	21 (67.7%)	22 (73.3%)	22 (73.3%)	
Expert	32 (26.2%)	7 (22.5%)	10 (32.2%)	8 (26.6%)	7 (23.3%)	
BMI	27.8 (6.2)	27.8 (5.6)	29.4 (6.3)	26.6 (6.8)	27.3 (6.1)	.206
SF-12						
Physical Health	51.3 (6.0)	51.2 (6.4)	50.5 (5.4)	51.6 (5.9)	51.9 (6.2)	.236
Mental Health	49.1 (9.3)	50.5 (8.7)	47.8 (9.0)	49.9 (9.5)	48.2 (10.3)	.323
Exercise Stage						.147
Precontemp.	7 (5.7%)	0 (0.0%)	5 (16.1%)	1 (3.3%)	1 (3.3%)	
Contemplation	25 (20.4%)	5 (16.1%)	7 (22.5%)	5 (16.6%)	8 (26.6%)	

	All	CONTROL	ACT	DIET	ACT+DIET	p
Preparation	89 (72.9%)	25 (80.6%)	19 (61.3%)	24 (80.0%)	21 (70.0%)	
Action	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Maintenance	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
F&V Stage						.181
Precontemp.	15 (12.2%)	3 (9.6%)	8 (25.8%)	3 (10.0%)	1 (3.3%)	
Contemplation	7 (5.73%)	1 (3.2%)	1 (3.2%)	3 (10.0%)	2 (6.6%)	
Preparation	99 (81.1%)	27 (87.0%)	21 (67.7%)	24 (80.0%)	27 (90.0%)	
Action	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Maintenance	1 (0.8%)	0 (0.0%)	1 (3.2%)	0 (0.0%)	0 (0.0%)	

Table 2

Mixed-Effect Model of Pedometer Steps (Intercept is the control condition on day 0, and everything else is in terms of differences from intercept)

	Estimate	Std. Error	t value
(Intercept)	7398.207	604.985	12.229
day	8.537	6.419	1.330
ACT	−1175.186	850.936	−1.381
DIET	−715.795	859.239	−0.833
ACT+DIET	94.765	856.220	0.111
day:ACT	9.292	9.126	1.018
day:DIET	−16.063	9.192	−1.747
day:ACT+DIET	−7.588	9.229	−0.822

Table 3

Model of Fruit and Vegetable Consumption (baseline scores are centered to the global mean: “Intercept” is the estimated marginal mean for the CONTROL group at T1, and the 3 “Condition” coefficients are offsets from intercept)

Coefficients:	Estimate	Std. Error	t value	p
(Intercept)	9.0120	0.6631	13.591	< 2e-16
fvs.total.base.c	0.6106	0.1028	5.941	3.89e-08
Condition ACT	1.4186	0.9215	1.540	0.126738
Condition DIET	3.4336	0.9566	3.589	0.000509
Condition ACT+DIET	2.1657	0.9381	2.309	0.022965

Table 4

Self-Report Satisfaction Results

Measure	Anchor 1	Anchor 7	Mean	SD
Satisfaction with Agent	Not at all	Very satisfied	4.30	1.84
Ease of Use	Difficult	Easy	4.8	1.97
Desire to Continue with Agent	Not at all	Very much	3.75	2.18