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Feedback strategies to raise awareness of personal dietary intake: results of a randomized controlled trial

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Abstract

Background. Feedback is a strategy that can be used to influence awareness of dietary habits. Feedback was applied in an interactive computer-tailored intervention and in printed self-test forms.

Methods. A randomized controlled trial with a 3 (study groups) × 2 (higher vs. medium or lower educational level) design was conducted. Adult subjects ($N = 304$) were randomly assigned to a feedback group or the control group. Immediate impact on realism of self-rated intake levels of fat, fruit, and vegetables were tested, as were intentions to change.

Results. Self-rated fat intake compared to others was more realistic among respondents with a medium or lower educational level in the tailored intervention group. Self-rated fruit intake compared to others was more realistic in the tailored intervention group. Self-rated fat intake was more realistic in the tailored intervention than the self-test group. Intention to reduce fat consumption was greater in the tailored intervention group. Intention to eat more vegetables was greater in the tailored than in the self-test group. Subjects rated the tailored intervention as more effective, more personally relevant, more individualized, and providing more new information.

Conclusions. Only the tailored intervention had an immediate impact on awareness and dietary change intention and was appreciated better than both other interventions.

Keywords: Feedback; Interactive computer tailoring; Self-test forms; Nutrition education

Introduction

Intake levels of (saturated) fat are above, while intake levels of fruit and vegetables are below recommendations in the Netherlands, as well as in most other Western countries [1,2]. Lack of awareness of personal dietary habits has been identified as a major barrier in motivating people to change to healthier diets [3,4]. To overcome this barrier, it is essential to find and test strategies that increase awareness. Weinstein's Precaution Adoption Process Model [5] emphasizes the importance of awareness in behavioral change and proposes personalized and normative feedback to influence awareness. The present study applied personalized and normative feedback in two interventions, (1) an interactive computer-tailored program providing extensive feedback based on a thorough diagnosis and (2) printed self-test forms, providing brief feedback based on a short and easy-to-administer self-diagnosis. In a randomized controlled trial, the effects of both interventions were compared with those in a control group that received general nutrition information. Before presenting and discussing the results, we introduce the rationale and theoretical foundation of the study.

Diets low in (saturated) fat and high in fruit and vegetables are associated with a decreased risk of cardiovascular disease and cancer [6]. The Health Council of the Netherlands recommends diets with no more than 10% of energy intake from saturated fat and no more than 35% of energy intake from total fat. The latter officially only applies to people with or at risk for becoming overweight. This is, however, the majority of the population. Recommendations for vegetables and fruit are at least 200 grams (2.5 servings) and two pieces (2 servings) each day [7]. According to the most recent national food consumption survey, intake levels

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of fat are substantially higher, while intake levels of fruit and vegetables are substantially lower than these recommendations. Average intake of saturated fat constituted 14% of the energy intake and that of total fat 37%. Average intake levels of vegetables and fruit were 123 (1.5 servings) and 105 grams (1 serving), respectively [8]. Contrary to these "objective" findings, many people are convinced that their diets are healthy and therefore do not experience a need to change [9,10]. The discrepancy between more objectively measured intake levels and self-rated intake levels can be defined as lack of awareness, which is a barrier for motivation to change.

The role of awareness is emphasized in Weinstein's Precaution Adoption Process Model as a prerequisite of contemplating behavioral change [5]. The model describes three phases through which awareness of personal risk behavior emerges. For a person to become fully aware (phase three) of a personal risk behavior (e.g., my *personal* intake of saturated fat is too high), it is important that he/she has first heard of the health risk associated with that behavior (phase one; e.g., high saturated fat intake can increase the risk of cardiovascular diseases) and that he/she knows that the risk behavior is prevalent (phase two; e.g., knowing that many *other people* eat too much saturated fat). In the Netherlands, phase two now seems to have been reached. People know that consuming too much fat and too little fruit and vegetables is detrimental to health and they are convinced that many (other) people eat too much fat and too little fruit and vegetables [11]. Risk perception research, however, has shown that although people might be convinced of the risk for others, they tend to think of themselves as being less at risk. This is referred to as unrealistic optimism and is often seen in judgments of personal risks [5,12]. Such an optimistic bias seems to be prevalent in estimating dietary behavior as well: many people estimate that they eat less fat and more fruit and vegetables than their peers do. The estimation of "personal intake compared to others" correlated strongly with self-assessment of "personal intake" which in turn was found to be the best predictor of intention to change in studies by Brug et al. [13,14]. As long as an optimistic bias about personal intake compared to others persists, transition from phase two to phase three will not occur.

In the Precaution Adoption Process Model, personalized feedback on individual risk behavior (personal feedback) and information about the risk behavior of others (normative feedback) are considered to be major determinants of the transition from phase two to phase three [5]. Although the model was originally proposed in the context of precautions against health risks, or external hazards, we think that the model may also apply to the risk *behaviors* that may cause the actual health risk. Therefore, providing feedback would be an appropriate strategy to enhance awareness of personal risk behavior and motivate people to change to healthier diets.

Providing personal and normative feedback on dietary habits requires a method that allows one to first assess the personal risk behavior. Furthermore, since lack of awareness of dietary habits seems to be prevalent among all age groups and all educational levels in the Netherlands [15], the method should be able to reach large groups of people. In individual counseling, feedback can be personalized to a very high extent, but it cannot reach large groups of people. At the other end of the "personalization continuum," mass media interventions can reach large groups of people, but with a minimum of personalized feedback. In the present study we tested two methods of providing feedback, which are somewhere in between these two extremes, i.e., computer tailoring and printed self-test forms. The principle of each method is described briefly below, followed by the specific hypotheses of the study.

Computer tailoring is a relatively new technique that has been applied and tested during the last decade for the purpose of influencing various health-related behaviors [16–18]. Computer-tailored interventions were generally found to be more effective in influencing smoking behavior [18,19], in encouraging participation in breast cancer screening [20,21] and in promoting healthy dietary habits [16]. Computer-tailored information is generated by means of three interrelated components, a theory-driven diagnostic tool to diagnose risk behavior and related determinants, a message library containing feedback messages for all possible diagnoses, and a computer program that selects, through a set of algorithms, the messages that match the diagnosis [16,22]. The set of selected diagnosis-matched messages forms the personalized feedback. The contents of the tailored information depend on the theoretical perspective from which the tailoring program is developed. For the purpose of influencing awareness of dietary habits, personal and normative feedback on intake levels can be provided. In addition to this, information addressing attitudes, social influence, or self-efficacy expectations could be provided to guide people through further stages of change.

The computer-tailored interventions that have been tested to date have mainly consisted of printed materials, such as letters, newsletters, or magazines. The computer-based character of the tailoring technique, however, makes it suitable for use in more advanced applications, such as interactive programs on CD-ROM or the Internet. Technically, it is now possible to develop and implement these more advanced computer-tailored interventions, but before disseminating tailored (nutrition) interventions via the World Wide Web, it is important to evaluate the effects of this new application. An interactive web-based computer-tailored nutrition education program is one of the methods we used to provide feedback in the present study.

Printed self-test forms are the second method we used for providing feedback. This intervention, however much shorter and less individualized than the computer-tailored intervention, nevertheless offers the opportunity to provide people with dietary feedback and change information. An important advantage of self-test forms is that they are a relatively easy to develop and distribute tool for health

educators in an effort to increase awareness of dietary intake in large groups of people. They have therefore the potential of being used widely in health education practice. This makes it worthwhile to examine the effects of this easy-to-use-and-implement feedback intervention next to a more extensive tailored intervention. Printed self-test forms are well known and popular for their use in lifestyle magazines. These tests allow readers to learn about the "type" they belong to, with regard to, for example, emotional intelligence or sociability, and the best way to act if they belong to a particular type. Self-test forms like these are partly intended for entertainment, and are therefore relatively easy to use, but they may still be to some extent suitable to classify people into appropriate categories. Self-test forms can be developed for health education topics as well. As such, self-test forms can be found in many self-help manuals, but can also be printed in popular magazines or used as single forms. Self-test forms consist of a limited number of questions with a multiple-choice answering format. Each answer corresponds with a letter or a number. Summing up the numbers or letters received for each question gives a total score that classifies the respondent into a category. Brief information is then usually provided for each category. The contents of the questions and the information depend on the topic to be addressed in the self-test form. For the purpose of influencing awareness of personal intake of fat, fruit, and vegetables, the information could provide feedback on the assessed intake levels compared to the recommendations. The feedback should be different for each category. The self-test forms tested in this study were developed by the Dutch Nutrition Center [23], and aimed to increase awareness of dietary habits in large groups of people by providing dietary feedback and change information. The self-test forms were developed based on the results of studies in the Netherlands showing that lack of awareness was a major barrier toward dietary change (e.g., [3]). The self-test forms had not been evaluated on their effects before the present study.

The purposes of the present study were (1) to explore the immediate effects on awareness of and intention to change personal intake of fat, fruit, and vegetables of two methods of providing dietary feedback, and (2) to study differential effects of the interventions in groups with different levels of education. Differential effects were studied because highly educated people might be more attracted to comprehensively written materials, whereas lower educated people might be more attracted to short and entertaining materials. We conducted a randomized controlled trial in which the effects of the interventions were compared with those in a control group that received general nutrition information.

We hypothesized that:

- Both feedback interventions would have a greater impact on awareness and intention to change than the general nutrition information.
- Among the respondents with a higher educational level, the interactive computer-tailored intervention would have a greater impact on awareness and intention to change and would be more appreciated than the self-test forms and the general nutrition information.
- Among the respondents with a medium or lower educational level, the self-test forms would have a greater impact on awareness and intention to change and would be more appreciated than the computer-tailored intervention and the general nutrition information.

The present study provides information on the process of awareness raising as a prerequisite for dietary change and on the possible value of two feedback interventions in influencing awareness and intention to change intake of fat, fruit, and vegetables.

Methods

Participants

Participants were 304 students and employees of adult education centers. In line with the demands of the Medical Ethics Committee, general letters explaining the purpose and procedure of the study were distributed among a large group of potential participants. Employees could enroll by replying to an e-mail message that was sent out after the letters had been distributed. Students were invited to participate in the study during one of their classes. We emphasized that anyone could enroll, regardless of their interest in nutrition. Recruitment activities were stopped when over 300 respondents had registered for participation. Respondents had to be between 30 and 65 years of age and sufficient understanding of Dutch was required. A 9 Euro gift voucher was offered to each participant and a trip to Paris for two was raffled among the participants of the study.

Study design and procedure

A pretest-posttest randomized controlled trial with a 3 (two intervention groups and one control group) $\times$ 2 (higher versus medium or lower educational level) design was conducted. Respondents from various educational levels were separately assigned to one of the conditions to ensure an even distribution of educational levels over all three conditions. Two educational levels were distinguished by assigning respondents to either the higher educational level group (university degree or higher professional training) or the medium or lower educational level group (all education below higher professional training).

The experiment was carried out on the site where participants were working or attending their classes, i.e., in offices or classrooms. A maximum of 10 respondents participated in the study simultaneously, but care was taken that they could not see or communicate with each other.

Appointments as to where and when to participate in the study were made with the people who enrolled. When arriving at the agreed location, respondents, who had already been informed about the experiment by means of the letter, were asked to give their informed consent, after which the study procedure was explained in further detail. Lots were drawn to assign each participant to one of the three conditions. Respondents who were assigned to the tailored intervention group started by going through the interactive computer-tailored program, i.e., filling out the assessment, which was at the same time the baseline questionnaire, and reading the feedback. Respondents with poorly developed computer skills received brief instructions on how to proceed through the program. Respondents in the self-test form and control groups were first asked to fill out a printed baseline questionnaire. After completion of this questionnaire, self-test forms and printed general nutrition information letters were handed out to respondents in the self-test form and the control group, respectively. Respondents in all three study groups were asked to fill out a printed posttest questionnaire after they had completed and read the intervention materials. Participation in the study ended with filling out this last questionnaire. The whole procedure took 30 to 45 minutes.

Measurement

Demographic variables, intake levels of fat, fruit, and vegetables, and psychosocial variables were assessed by using an 84-item self-administered questionnaire. The questionnaire started with assessing age, sex, weight, height, educational level, living situation (alone/together), use of special diets, and whether or not the respondent regularly did the cooking or the shopping for the household. A validated food frequency questionnaire was used to assess intake levels of fat, fruit, and vegetables [24,25]. The first part of the food frequency questionnaire assessed the frequency of use of 19 product categories that contribute most to saturated fat intake, as well as the quantities and types of product (high fat, medium fat, or low fat). The answers to the food frequency questionnaire were used to calculate a fat score, ranging from 0 to 80, which reflects total saturated fat intake. This short and easy-to-administer screening instrument allowed us to rank respondents according to individual fat intake and to detect changes in individual fat consumption [24]. In the second part of the food frequency questionnaire, frequency (how many days a week) and quantities (amount per day) of fruit, fruit juice, and vegetable consumption were assessed. This information was used to calculate the average number of servings of fruit and vegetables per day [25].

Awareness of dietary intake was assessed by measuring realism in self-rated intake compared to others, and in self-rated intake. Respondents were asked to rate their intake compared to others (much lower to much higher) and their personal intake (very low to very high) on five-point scales. Measures for "realism in comparison to others" and "realism in self-rated intake" were constructed by comparing the self-ratings with objectively assessed intake levels, in terms of below, above, or equal to average peer intake levels (peer intake levels were based on data from prior food consumption surveys) and in terms of below, above, or equal to recommended intake levels. Respondents whose self-rated intake level corresponded with the objectively assessed intake level were classified as "realistic," others as "unrealistic."

Transtheoretical stages of change were assessed, following the staging algorithm as described by Brug et al. [9]. Attitudes ("Do you think it is bad or good to eat less fat/more fruit/more vegetables?") and self-efficacy ("Do you think it is difficult or easy to eat less fat/more fruit/more vegetables?") were measured on five-point scales (very bad to very good; very difficult to very easy) (see also [26]). These variables were only used to tailor the feedback in the computer-tailored intervention.

The posttest questionnaire differed somewhat in length between the three conditions, because specific questions on attractiveness, usability, and experience with self-tests were added in the tailored and self-test groups. Thus, the posttest in the tailored intervention condition had 49 items, that in the self-test condition had 55, and that in the control condition 46. The first part of the questionnaire assessed awareness in the same way as described for the baseline questionnaire. Furthermore, transtheoretical stages of change and general intention to change fat, fruit, and vegetable consumption (seven-point scales) were assessed. The second part of the questionnaire measured appreciation, relevance, credibility, and use of the intervention (see Tables 3 and 4). These questions were measured on visual analog scales (100 mm), anchored by "completely disagree" and "completely agree." The questionnaire ended with items about experience and skills in using the computer and the internet ("How often do you use a computer/the internet?" "How easy is it for you to use a computer/find something on the internet?"), on six- and five-point scales, respectively.

The tailored intervention

The components of a computer-tailored education program are a theory-driven diagnostic tool to assess feedback goals for each participant, a message library containing feedback messages for all possible diagnoses, and a computer program that selects the feedback messages that correspond with each specific diagnosis [16]. The whole program can be provided in printed form or, for more advanced application, interactively on the computer. In the present study, an interactive web-based intervention was used. The intervention was applicable for use on the internet, but to create a controlled situation, we had the program installed locally on hard disk. The diagnostic tool was the baseline questionnaire described in the previous subsection.

The program started with a homepage describing what a tailored nutrition education program is, for whom this particular program was intended, who had produced it, and

how it should be used. After reading this homepage, a respondent could start going through the program by clicking the button for fat, fruit, or vegetables in the menu bar on the left side of the screen. Although a random sequence was possible, we asked our respondents to follow the sequence in the menu bar, starting with fat and ending with fruit. A fourth button gave access to a section with low-fat, high-vegetable recipe suggestions.

Each topic started with a brief general introduction on the subject, after which respondents could click through to the diagnosis section. The questions appeared on the screen, one at a time, with the next question appearing as soon as the previous one had been answered. Irrelevant questions, for example questions on meat consumption for respondents who had already indicated that they never ate meat, were skipped. After all relevant questions had been answered, the feedback appeared on the screen, in an attractive layout with a colored background and illustrations accompanying the texts. Each feedback section started with a brief introduction and an overview of the topics to be discussed. In the section on fat, feedback was given on how the respondent's computed fat score compared to the recommended intake levels. Respondents who had underestimated their fat intake were confronted with their misconception, and those whose computed fat score exceeded the average fat score of others of the same age and sex were also given feedback on their personal fat score compared to that of others. This information was both written and visualized in a graph. Additional information was given on the most important sources of fat in the diet and on ways to replace these products by low-fat alternatives. The information ended with a message that encouraged people in precontemplation to reconsider their fat intake and those in contemplation and preparation to proceed to action, while respondents in action and maintenance were reinforced to continue with their changes. These messages differed for positive, negative, or neutral attitudes and positive, negative, or neutral self-efficacy expectations. Finally, there were messages on how to succeed in eating low-fat food in possibly difficult situations (when in a restaurant, when eating with one's family or friends, when at a party, when hungry between meals), for those respondents who perceived these situations as difficult.

In the fruit and vegetable sections, feedback was given on the computed intake compared with both the recommendations and the self-rated intake. Respondents who did not meet the recommended levels were given suggestions on how to increase consumption by eating fruit or vegetables either more frequently or in larger portions. Suggestions were also made on how to make it easier to eat fruit and vegetables in the recommended amounts every day. Photographs of recommended portion sizes of three kinds of commonly eaten vegetables were shown in the feedback for respondents who did not meet the recommended intake levels. The information on fruit and vegetable consumption also ended with a message tailored to the respondents' stage of change.

The recipe part included 56 recipes for low-fat, high-vegetable main courses, desserts, and snacks, which respondents could browse through. The message library had been tested in earlier studies [15,26] and was revised and extended for the present study.

A computer program, written in Visual Basic, enabled the creation and storage of all essential parts of the tailored intervention (screening instrument, message library, tailoring algorithms, and layout of the final feedback). Java script routines generated the tailored messages and created a web site consisting of HTML pages. The program was created for use on the internet, but could also be used on CD-ROM or hard disk. Internet Explorer 5.0 was the browser used to run the program. The web-based program was pretested in two sessions and changes were made according to the findings of these pretests.

The self-test forms

The self-test condition involved two printed self-test forms, one for fat and one for fruit and vegetables. The tests used in the present study were developed by the Dutch Nutrition Center in collaboration with other Dutch organizations active in the field of health education and promotion, but had never been tested for their effects.

The self-test forms contained a brief introduction on the health benefits of eating either moderate amounts of fat or sufficient amounts of fruit and vegetables. The fat-test form consisted of 14 questions on the frequency with which low- or high-fat foods were consumed (for example, "when I eat cheese, I eat low-fat cheese," with the answering options "yes," "no," and "sometimes"). The low-fat answer would yield the lowest and the high-fat answer the highest score for the question. The self-test forms had a "scratch card" format. The score on the question could be obtained by scratching open a box that covered a number. After the respondent had scratched open a box for each of the questions, the points that had been received could be added up to a total score, with a minimum of 13 and a maximum of 60 points. A total score of less than 22 categorized the respondent in a group with a saturated fat intake in agreement with recommendations. A total score between 22 and 30 categorized the respondent in a group with room for improvement in saturated fat intake. Scores over 30 categorized the respondent in a group of high saturated fat consumers who were strongly recommended to reduce their fat consumption. For each category, feedback was given on how the total fat score (based on the brief assessment) compared with recommendations. In categories two and three, the feedback also referred to general suggestions for reducing fat consumption by either eating fewer products containing fat or replacing high-fat products by low-fat alternatives.

The fruit and vegetables self-test form used six questions to assess the usual frequency and amounts of the respondents' fruit and vegetables consumption. The points that had been received for each question led to a total score that

corresponded with a particular category, as follows: (1) sufficient amounts of fruit and vegetables, (2) a certain amount of fruit and vegetables but leaving room for improvements, or (3) insufficient amounts of fruit and vegetables. Each category was given feedback on how the assessed intake compared with recommendations and referred to general suggestions on how to improve fruit and vegetable consumption by eating fruit and vegetables with more than one meal and between meals.

The layout of both tests was in bright colors with photographs of low-fat products and fruit and vegetables. The tests had been validated and tested for their appreciation before the start of the present study [23].

Control condition

Respondents in the control condition received a nontailored nutrition information letter with information from brochures by the Dutch Nutrition Center. The letter provided information on the importance of a healthy diet and on the fact that Dutch people eat too much fat and too little fruit and vegetables but that a lot of people do not know they are eating unhealthy diets themselves. The section on fat listed the risks of high-fat diets and emphasized that anyone who eats too much fat is at risk. Low-fat alternatives were given for some high-fat products that are very common in the Dutch diet. The fruit and vegetable part emphasized the positive consequences of eating more fruit and vegetables, followed by suggestions on how to increase fruit and vegetable intake. The letter ended with two low-fat recipes. The four-page letter was illustrated with cartoons.

Statistical analyses

Binary logistic regression analyses were conducted to test the equality of study groups at baseline. Age, gender, consumption levels of fat, fruit, and vegetables, self-rated intake, and self-rated intake compared to others were the independent variables in the equations.

The impact of the interventions on awareness (i.e., being realistic) was tested by means of logistic regression analyses, with "realism in comparison with others" and "realism in self-rated intake" at posttest as the dependent variables, and study group and the baseline measure of realism as the independent variables. To study group-by-education interaction effects, this interaction term was included in the logistic regression analyses. Differences in -2 log likelihood (comparing the fit of a more complex to a more basic model) between the model with the interaction term and the more basic model without this term were computed. In the analyses where the model with interaction was significantly more predictive (i.e., the decrease in -2 log likelihood was significant), separate analyses were conducted for groups with medium or lower and higher educational levels. Otherwise, the basic model was used.

In logistic regression analysis with three groups, two dummy variables and one reference category are created, thus comparing two groups separately with one reference group. In our study, the control condition was the reference group. However, to detect possible differences between the two feedback interventions, additional analyses were conducted, with the self-test condition as the reference group.

Differences between the study groups in the intention to eat less fat and more fruit and vegetables, were studied by using two-way analyses of variance, with study group and educational level as factors, thus studying intervention and intervention-by-education interaction effects. Tukey was used as the post hoc comparison test.

People with unfavorable diets should profit most from nutrition interventions. To study the intervention effects in this specific subgroup, the same analyses were repeated for the group of respondents that did not meet the recommended intake levels at baseline.

Differences in subjective impact, use, and appreciation of the interventions were studied with two-way analyses of variance and Tukey post hoc comparison tests. The factors in these analyses were study group and educational level.

Differences with $P < 0.05$ were considered significant and differences with $P < 0.10$ as borderline significant. Analyses were two-tailed.

Results

Participants

A total of 304 respondents participated in the study. The data of 300 respondents were valid for analysis. The information of four respondents in the tailored intervention group was lost due to technical problems. Another four respondents in the tailored intervention group had incomplete data sets; two respondents had completed the whole program, but the information on fat consumption had not been recorded; two other respondents had only completed the part on fat because it took them too long to complete the entire program. For these respondents, the data of the completed and recorded topics were included in the analyses. Analyses were conducted on 96 subjects in the tailored intervention group, 100 subjects in the self-test group, and 102 subjects in the control group.

Baseline measurements

Mean age of the respondents was 44 years (SD = 9.7). Sixty percent of the respondents were female. Almost half of the respondents (47%) had a higher educational level (university degree or higher professional training); the other half (53%) had a medium educational level (medium level professional training or high school) or a lower educational level (lower level professional training or primary school).

The average fat score was 18.5 (SD = 6.4) points, the average vegetable intake was 195 grams (2.4 servings, SD

Table 1
Percentages of realistic respondents at baseline and post test

	Tailoring		Self-tests		Control	
	Baseline	Post test	Baseline	Post test	Baseline	Post test
Fat intake						
Compared to others	30%	49%	45%	44%	45%	39%
Self-rated intake	28%	42%	33%	35%	33%	43%
Vegetable intake						
Compared to others	43%	44%	52%	53%	49%	49%
Self-rated intake	42%	43%	38%	41%	33%	40%
Fruit intake						
Compared to others	54%	60%	53%	48%	53%	50%
Self-rated intake	46%	54%	53%	56%	55%	57%

= 100 grams), and the average fruit intake was 1.4 pieces (1.4 servings, SD = 1.2 pieces) per day.

Fifty-four percent of the respondents in the tailored intervention group, 46% in the self-test group, and 43% in the control group had diets that were not in agreement with the recommended fat intake levels. Forty-nine percent, 50%, and 52% of the respondents in the tailored, self-test, and control groups, respectively, did not eat 200 grams of vegetables each day, while 47%, 51%, and 52% in the tailored, self-test, and control groups did not meet the recommendation of two pieces of fruit each day.

None of these demographic variables, average intake levels, or key outcome variables differed significantly between the study groups.

Impact on awareness

Table 1 lists the percentages of realistic respondents at baseline and at posttest. In the analyses with "realism in comparison with others" as the dependent variable, the model with interaction was only found to be significantly more predictive with regard to fat intake. Separate analyses of the groups with medium or lower and higher educational levels revealed that only respondents with a medium or lower educational level in the tailored intervention group were significantly more likely to be realistic about their fat intake compared to others (odds ratio [OR] = 11.4, confidence interval [CI] = 12.8–124.1). The basic models revealed a borderline significant effect for "realism in fruit intake compared to others," with respondents in the tailored intervention group more likely to be realistic (OR = 2.0, CI = 1.0–4.2).

In the analyses with the self-test group as the reference, respondents in the tailored intervention group were significantly more likely to be realistic about their fat intake compared to others (OR = 2.6, CI = 1.1–5.8) and about their fruit intake compared to others (OR = 2.2, CI = 1.0–4.6).

With "realism in self-rated intake" as the dependent variable, none of the models with interaction were significantly more predictive than the basic model. Respondents in both feedback interventions were no more likely than respondents in the control group to be realistic about their self-rated fat, fruit, and vegetable intake. In the analyses with the self-test group as the reference, respondents in the tailored intervention group were significantly more likely to be realistic about their self-rated fat intake (OR = 2.3, CI = 1.0–5.1).

The subgroup of respondents that did not meet the recommendations showed similar effects for the same groups on the same variables.

Intention to change

Main effects on intention to change (see Table 2) in the group as a whole were found for the intention to eat less fat and more vegetables. Intention to eat less fat was significantly greater in the tailored intervention group than in the two other groups and was greater in the control group than in the self-test group. Intention to eat more vegetables was significantly greater in the tailored intervention group than in the self-test group.

For the subgroup of respondents whose diets were not in agreement with recommendations, main effects were found for the intention to eat less fat, more vegetables, and more fruit. Respondents in the tailored intervention group had a greater intention to change than respondents in the self-test group. For fruit, there was an additional borderline significant ($P = 0.08$) difference in intention to change between the tailored intervention and control groups. There were no intervention-by-education interaction effects for any of the intention items.

Subjective impact, use, and appreciation

The subjective impact and usability measures (see Table 3) only revealed main effects. Respondents in the tailored intervention group stated significantly more often than respondents in the two other groups that they, as a result of the intervention, had changed their opinion about their dietary habits [$F(2, 290) = 9.7$, $P = 0.00$] and intended to change their diet [$F(2, 291) = 13.4$, $P = 0.00$]. Respondents in all

Table 2
Means and standard deviation for intention to change, *F* values for main and group-by-educational level interaction effects and post hoc comparison

	Tailoring (T)	Self-tests (ST)	Control (C)	*F* value		
				Main effect	Interaction effect	Post hoc comparison
Group as a whole						
Intention to eat less fat	0.72 (1.21)	−0.14 (1.30)	0.29 (1.26)	11.08[b]	0.60	T > C > ST
Intention to eat more vegetables	0.22 (1.33)	−0.26 (1.21)	0.10 (1.21)	3.93[a]	1.51	T > ST
Intention to eat more fruit	0.58 (1.32)	0.18 (1.20)	0.51 (1.34)	2.76	2.47	
Group of respondents with diets not in agreement with recommendations						
Intention to eat less fat	0.96 (1.15)	0.22 (1.15)	0.61 (1.20)	4.05[a]	0.54	T > ST
Intention to eat more vegetables	0.64 (1.15)	−0.10 (1.25)	0.15 (1.23)	5.08[b]	2.09	T > ST
Intention to eat more fruit	1.27 (1.01)	0.53 (1.19)	0.75 (1.27)	5.31[b]	2.10	T > ST, C*

[a] $P < 0.05$.
[b] $P < 0.01$.
* Borderline significant.

three groups rated the information equally attractive to read, but the information in the self-test forms was read significantly less extensively than the information in the control group [$F(2, 290) = 4.3$, $P = 0.015$]. The tailored intervention program was significantly more likely to be used again than the self-test forms and the nutrition information letter [$F(2, 288) = 4.3$, $P = 0.014$].

Of all items assessing appreciation of the intervention materials (see Table 4), a significant interaction effect was only found for newness of the information on fat and vegetables. Separate analyses for the groups with higher and medium or lower educational levels revealed that only the respondents with a medium or lower educational level in the tailored intervention group rated the information on fat and vegetables as more new to them than respondents in the two other conditions [for fat: $F(2, 151) = 12.8$, $P = 0.00$; for vegetables: $F(2, 150) = 10.5$, $P = 0.00$]. With regard to the newness of the information on fruit, only a main effect was found, with the information provided in the tailored intervention rated as more new than the information in the other two groups [$F(2, 288) = 7.6$, $P = 0.001$].

All study groups and educational levels rated the information on all three topics as equally credible, interesting, and comprehensible. Main effects were found for the personal relevance of the information [for fat: $F(2, 288) = 6.14$, $P = 0.002$; for vegetables: $F(2, 288) = 5.7$, $P = 0.004$; for fruit: $F(2, 287) = 2.9$, $P = 0.054$] and for the extent to which the information was individualized [for fat: $F(2, 289) = 23.7$, $P = 0.00$; for vegetables: $F(2, 289) = 21.9$, $P = 0.00$; for fruit: $F(2, 287) = 14.2$, $P = 0.00$]. The information provided to the tailored intervention group was perceived as being of greater personal relevance and more individualized than the information provided to the two other groups. The information on vegetables was rated as more personally relevant in the self-test condition than in the control condition.

Discussion

The results of the present study, in which we investigated the immediate impact of two different methods of providing people with feedback about their fat, fruit, and vegetable consumption, indicate that only the interactive computer-tailored nutrition education program had a greater immediate impact on awareness and intention to change than the general nutrition information. Further, the tailored intervention was rated as more effective by respondents and was appreciated better than the control intervention. The hypothesized effects on awareness and intention to change for the self-test form intervention were not found. The additional analyses in which the two feedback interventions were compared did not show results in favor of the self-test forms either. The tailored intervention resulted in significantly more realism about the respondents' own dietary intake, a

Table 3
Subjective impact and use of the nutrition information in the three conditions (means, standard deviations and post hoc comparison)

	Tailored (T)	Self-test (ST)	Control (C)	Post hoc
Changed opinion about diet as a result of the information	59.8 (28.5)	42.5 (31.5)	43.1 (32.9)	T > ST, C
Intend to change diet as a result of the information	64.8 (28.6)	42.4 (31.6)	50.4 (31.8)	T > ST, C
How much of the information read	93.0 (11.6)	89.1 (18.4)	94.9 (11.9)	C > ST
Use the program/read the information again when possible	70.3 (32.5)	57.3 (33.0)	58.15 (36.4)	T > ST, C
Attractiveness of information	85.0 (16.7)	81.3 (22.3)	80.5 (22.1)	

Table 4
Appreciation of the nutrition information in the three conditions (means, standard deviations and post hoc comparison)

	For fat				For vegetables				For fruit			
	Tailored (T)	Self-test (ST)	Control (C)	Post hoc	Tailored (T)	Self-test (ST)	Control (C)	Post hoc	Tailored (T)	Self-test (ST)	Control (C)	Post hoc
The information was understandable	89.2 (16.4)	89.7 (13.0)	92.3 (12.0)		90.7 (11.9)	91.4 (10.4)	91.3 (13.3)		91.7 (11.0)	90.4 (12.0)	91.9 (13.2)	
The information was interesting	78.2 (22.2)	73.0 (24.7)	74.5 (25.3)		73.3 (26.5)	68.8 (28.2)	75.3 (25.5)		75.5 (25.1)	69.3 (27.5)	77.0 (24.1)	
The information given was credible	85.1 (21.4)	85.1 (16.9)	88.0 (18.8)		87.6 (14.6)	85.0 (17.1)	90.3 (15.6)		87.8 (16.4)	85.6 (16.1)	89.1 (16.2)	
The information was new to me	38.1 (34.3)	21.2 (25.6)	18.2 (25.2)	T > ST, C[a]	33.2 (32.0)	21.3 (26.0)	17.0 (23.2)	T > ST, C[a]	31.5 (30.5)	21.9 (25.4)	16.7 (22.9)	T > ST, C
The information was of personal relevance to me	75.1 (23.7)	65.1 (29.2)	60.6 (33.7)	T > ST, C	70.5 (26.6)	59.3 (31.5)	55.9 (35.7)	T > ST, C	71.8 (26.5)	61.2 (32.5)	63.5 (34.4)	T > ST
The information was individualized	74.2 (26.2)	51.6 (31.7)	45.2 (32.3)	T > ST, C	69.5 (28.0)	51.9 (31.9)	39.8 (33.4)	T > ST > C	70.4 (27.5)	49.6 (32.3)	48.7 (34.1)	T > ST, C

[a] These post hoc differences apply only to the groups with medium or lower level of education.

greater intention to change, more subjective impact, and greater appreciation than the self-test form intervention.

The hypotheses that the tailored intervention would outperform the self-test form intervention only in the group with a higher educational level whereas the reverse was expected for the group with a medium or lower educational level were not supported by the data either. The few differences in intervention effects for different levels of education indicated that the respondents with a medium or lower educational level may have benefited more from the tailored intervention. This is in line with recent findings by Brug and Van Assema [15]. It appears that extensive written materials, even in a digital form, appeal to people with a medium or lower educational level as well. It must be noted, however, that all participants in our study had a certain level of education. The results are not applicable to groups with no formal education at all.

Although we found some effects of the tailored intervention on awareness variables, the impact was limited to an increase in "realism in comparison with others." Based on the theoretical framework, we expected that the personal and normative feedback would have resulted in more realism in both awareness variables. That the intervention caused more realism in comparison with others may indicate a first step toward a more realistic self-rated intake, but the next step, actually becoming more realistic in self-rated intake, may take more time. Whether or not this argument holds will have to be investigated in studies of the longer-term effects of feedback on awareness of personal intake levels.

The tailored intervention seemed to be most effective at influencing awareness variables and intention to change for fat intake, whereas effects on awareness and intention to change for fruit and vegetables were hardly found. These findings are in line with earlier studies that found tailored interventions to be more effective in changing (cognitions related to) dietary fat consumption than in changing fruit and vegetable intake [16]. Possible explanations for the absence of an impact on awareness and intention to change for fruit and vegetables in this study are that, at baseline, respondents seemed already more realistic about their fruit and vegetable intake than about their fat intake. This higher level of baseline awareness may make it more difficult to accomplish changes by raising awareness. This higher baseline awareness level may also indicate that lack of awareness as a barrier toward motivation to change is less prominent for fruit and vegetable consumption than it is for fat consumption, which may explain the absence of an impact on intention to change. Other explanations may be found in the intervention itself, or in the sequence in which we asked the respondents to use the tailored information. The information about fruit and vegetables was not as extensive as the information on fat consumption. Furthermore, we asked respondents to start the tailored intervention program with the information on fat consumption. This sequence may have resulted in a more intensive processing of the infor-

mation on fat than that on vegetables and fruit. In future studies, the information provided on fruit and vegetable consumption may have to be extended and the effect of sequence in which the information is used should be explored.

The subjectively perceived and reported effects of the tailored intervention were significantly better than those of the interventions in the two other groups. Furthermore, the tailored intervention was appreciated better on the important features of effective nutrition interventions [27], viz., personal relevance, individualization, and novelty of information. This finding is consistent with those of previous studies on computer-tailored nutrition education (e.g., [28,29]). It is promising that these positive subjective and appreciation effects have now also been found for an interactive web-based computer-tailored intervention.

Even though there seem to be some similarities, the comparability of the results of the present study with those of previous studies is limited, because most studies have measured short-term (1 month) or longer-term (>4 months) effects, and have mainly focused on behavioral change [16,29] rather than on immediate effects on prebehavioral determinants. Furthermore, only one earlier study assessed effects of tailored information on awareness as an important determinant of motivation to change behavior [30]. Finally, the results of the present study are not readily comparable with those of other studies because the tailored interventions that have been reported to date have mainly been printed versions. The number of published studies into the effects of more advanced interactive and multimedia tailored interventions is now growing (e.g., [31,32]), but is still too small to make valid comparisons.

The tailored intervention is developed both for people who do and for those who do not have diets in agreement with recommendations, but the latter group should benefit most from the intervention. In our study, however, there was no greater impact in the group of people with unfavorable diets. A possible explanation for this comes from the body of literature on feedback (e.g., [33–35]) from which it becomes clear that the working mechanism of feedback on behavioral change is not always straightforward, especially not among people who receive unexpected feedback information. Studies on dietary feedback by Bowen et al. [36], Brug et al. [26], and Van Assema et al. [37], for example, found that respondents in high-risk groups downgraded the accuracy, seriousness, or importance of the feedback information. Processes like these, or other, unknown processes, may account for the limited results of the tailored intervention, especially in the subgroup of respondents with diets that are not in agreement with recommendations. Improved understanding of the responses to feedback and the underlying processes of feedback may make it possible to more specifically address groups at high risk and increase the impact of feedback information.

The lack of an effect of the self-test form intervention may be attributable to the fact that the feedback provided was too brief, too general, and not seen as personally relevant or individualized. Thus, the self-test forms seem to lack the important features of successful nutrition education interventions. Additional research is needed to gain more insight into why this self-test form intervention failed to have an impact.

There were some limitations to the present study. Even though we tried to avoid selecting a sample of respondents who were already greatly interested in food and nutrition by emphasizing that anyone could enroll in the study, we still had a self-selected sample of respondents who may have been interested in nutrition more than average. That our sample included a higher proportion of respondents with diets in agreement with recommendations than the general Dutch population [8] may reflect this. However, respondents with fat, fruit, and vegetable intakes not in line with recommended intake levels were well represented in the study sample and all analyses were conducted separately for these respondents. These separate analyses showed similar results. Therefore, although the study sample may not have been representative for the entire Dutch adult population, the results of the present study also hold for people with less favorable diets. The interventions were tested in a highly controlled situation, which enhanced internal validity but probably lowered external validity. In a real-life setting, respondents could easily be distracted from properly using the tailoring program or filling out the self-test forms, which might lead to different effects. Furthermore, an electronic questionnaire was used as the baseline questionnaire in the tailored intervention group, whereas printed questionnaires were used in the two other groups. Studies comparing web-based questionnaires with paper-and-pencil questionnaires did not find differences between the two (e.g., [38]). Although we cannot rule out that the different methods of data collection had some effect in our study, we did not find any differences in intake levels or other key variables between the study groups at baseline. Since equal groups could be expected because of the randomization procedure, it seems that the different baseline data collection methods did not have a relevant effect on the results. Finally, although the way we conducted this randomized controlled trial allowed us to study immediate effects in a controlled situation, which was what we aimed for, we do lack information on long-term effects and effects on behavior. The results should therefore be interpreted with caution.

The present study is one of very few that provide information on the immediate impact of two different feedback interventions on prebehavioral determinants, as well as the first to specifically assess immediate impact on awareness of personal behavior. It demonstrates that an intervention can exert an effect immediately after exposure. In this study we found an immediate impact for only the interactive computer-tailored intervention and not for the self-test form intervention. This leads us to conclude that the interactive computer-tailored intervention is a more promising tool for inducing important steps toward behavior change. Future

studies should aim at testing the longer-term effects of the interactive computer-tailored intervention on awareness, intention, and behavior, and the possibilities of implementing and disseminating this intervention via the World Wide Web.

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