Self-Regulation Prompts Can Increase Fruit Consumption:

A One-Hour Randomized Controlled Online Trial

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Acknowledgement

Milena Koring is partly funded by the International Max Planck Research School 'The Life Course: Evolutionary and Ontogenetic Dynamics' (LIFE).

Abstract

Objective: The purpose was to examine whether a one-hour intervention would help increase fruit consumption in motivated individuals and to study the role of self-regulatory mechanisms in the behavior change process, with a particular focus on dietary planning and action control.

Methods: A randomized controlled trial compared a one-hour online intervention with controls in 791 participants. Dependent variables were fruit intake, planning to consume, and dietary action control.

Results: Experimental condition by time interactions documented superior treatment effects for the self-regulation group, although all participants benefited from the study. To identify the contribution of the intervention ingredients, multiple mediation analyses were conducted that yielded mediator effects for dietary action control and planning.

Conclusions: A very brief self-regulatory nutrition intervention was superior to a control condition. Dietary planning and action control seem to play a major role in the mechanisms that facilitate fruit intake.

Keywords: self-regulation, action control, planning, nutrition, randomized controlled trial

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Introduction

A balanced diet low in fat and rich in fiber and vitamins can facilitate health, physical fitness, and maintain body weight. However, dietary habits are difficult to change (Adriaanse, Gollwitzer, de Ridder, de Wit, & Kroese, 2011; de Bruijn, 2010; Luszcynska, & Cieslak, 2009; Verhoeven, Adriaanse, Evers, & de Ridder, 2012). Changing dietary behaviors requires not only basic knowledge about nutrition, but also motivational and volitional factors that guide self-regulatory processes.

The present study was designed to make a contribution to the understanding of psychological mechanisms that may lead to an increase in fruit consumption. In comparison to fat reduction, calorie restriction, or vegetable intake, fruit intake is intuitively more appealing to many people (Cox et al., 1998), and therefore, this constitutes a relatively easy task that is suitable as a starting point for major dietary changes (e.g., Armitage, 2007; Guillaumie, Godin, Manderscheid, Spitz, & Muller, 2012).

Various psychosocial factors are associated with dietary changes. To adhere to the recommendations, one has to become motivated to do so, and if one is motivated, one needs additional self-regulatory skills and behaviors to translate a dietary goal into action (Mann, de Ridder, & Fujita, in press). Some useful self-regulatory strategies have been identified, such as action control and planning.

However, it is not fully understood how these two factors interplay with changes in fruit consumption (Adriaanse et al., 2010; Guillaumie, Godin, & Vézina-Im, 2010). In the following sections, planning and action control in the context of dietary behaviors are described in detail.

Dietary Planning

Contrary to the ability to delay gratification, time discounting is a common tendency to prefer immediate pleasure from eating sweet and fatty foods over delayed benefits of a healthy nutrition. To counteract time discounting, one should make beneficial dietary behaviors more proximal. Instead of choosing long-term weight loss goals, people are better off when formulating short-term behavioral goals, such as eating fruit and vegetable today. This is done by planning that has been found to be effective in modifying various health behaviors (for an overview, see Gollwitzer & Sheeran, 2006). One can distinguish between action planning and coping planning, both of which have been found effective (Sniehotta, Scholz, & Schwarzer, 2006; Wiedemann, Lippke, & Schwarzer, 2012).

Action planning includes specific situational parameters ("when", "where") and an instruction of action ("how"). In contrast, the term coping planning refers to dealing with barriers that may impede the maintenance of a health behavior. Coping planning is a barrier-focused self-regulation strategy that comes on top of action planning. It represents a mental link between anticipated risk situations and suitable coping responses, and it can help overcome obstacles and protect good intentions from distractions. Whereas action planning is a prerequisite for initiating new behaviors, coping planning is a strategy that becomes more relevant after the intended behavior is initiated.

In the present study, an increase of an already prevalent behavior (fruit intake) is examined, and coping planning appears to be a suitable construct to address how people deal with temptations and barriers by mental simulation.

A meta-analysis has documented the role of planning in dietary changes (Adriaanse, Vinkers, de Ridder, Hox, & de Wit, 2011). Planning can be promoted effectively among individuals with self-regulatory deficits (Adriaanse et al., 2010). Planning facilitates the translation of intention into action. Studies have, therefore, specified planning as a mediator (e.g., Gutiérrez-Doña, Lippke, Renner, Kwon, & Schwarzer, 2009; Renner et al., 2008;

Richert et al., 2010; Scholz, Nagy, Göhner, Luszczynska, & Kliegel, 2009; Wiedemann, Lippke, Reuter, Ziegelmann, & Schwarzer, 2011). Hunter, McNaughton, Crawford, and Ball (2010) provided evidence of a mediating effect of dietary planning on fruit consumption among women. Several randomized controlled trials have documented the evidence in favor of such planning interventions in the context of dietary changes (e.g., Guillaumie et al., 2012; Kreausukon, Gellert, Lippke, & Schwarzer, 2012; Luszczynska, Tryburcy, & Schwarzer, 2007; Luszczynska, & Haynes, 2009; de Vet, de Nooijer, de Vries, & Brug, 2008; Wiedemann et al., 2012). More precisely, adding planning components to interventions has induced larger effects than interventions based solely on information provision (Stadler, Oettingen, & Gollwitzer, 2010). In the study by Wiedemann et al. (2012) fruit and vegetable intake increased with higher number of plans formed by the study participants, indicating that generating multiple plans benefits behavior change. Similarly, in the study by Luszczynska, and Haynes (2009) planning led to an average increased fruit and vegetable consumption of 0.45 servings among student nurses and midwives. In the study by Guillaumie et al. (2012) planning mediated the effects of intervention. However, action planning emerged as the mediator for vegetable intake, whereas coping planning mediated the intervention effect on fruit intake. Coping planning operated also as a mediator jointly with self-efficacy in the study by Kreausukon et al. (2012) in Thailand. In summary, planning components are useful self-regulatory intervention strategies to promote dietary behaviors, and should, therefore, be addressed in nutrition interventions.

However, there seems to be no study that has included dietary action control in the set of mediators, using fruit consumption as an outcome.

Action Control

There is a great deal of research on planning in the context of fruit and vegetable consumption, but other self-regulatory behaviors, such as action control, have received less

attention (Hagger, 2010). Facets of action control are typically included in intervention programs (Abraham & Michie, 2008), and therefore, the explicit assessment of this factor appears to be useful (Armitage, 2007; Sniehotta, Scholz, & Schwarzer, 2005). The question then is whether its inclusion would generate added value when it comes to explaining the mechanisms behind intervention effects on fruit consumption.

In contrast to planning, which is a prospective strategy (i.e., behavioral plans are made before a situation is encountered), action control is a self-regulatory strategy in which the ongoing behavior is retrospectively evaluated with regard to a behavioral standard. It refers to an in situ strategy including the investment of self-regulatory effort (inhibitory control), awareness of one's own standards, as well as self-monitoring behavior (Sniehotta et al., 2005). Action control supplements planning as a proximal volitional mediator.

In some studies, action control has been found to mediate the intention-behavior relation (Schüz, Sniehotta, Mallach, Wiedemann, & Schwarzer, 2009; Sniehotta, Scholz, & Schwarzer, 2005), although mainly in the context of promoting physical activity (e.g., Fleig, Lippke, Pomp, & Schwarzer, 2011). For example, in the intervention study in orthopedic and cardiac rehabilitation by Fleig, Lippke, Pomp, and Schwarzer (2011) changes in physical exercise were mediated by changes in action control. Further, a study on dental flossing (Schüz et al., 2009) has investigated the effects of an action control treatment (a dental flossing calendar). The intervention indeed led to higher action control levels at follow-up, thus indicating volitional effects. Action control facilitated flossing in volitional individuals only.

It is important to note that the adoption of a novel health behavior (e.g., flossing, condom use, and vaccination) is different from changes in ongoing health behaviors such as physical activity or dietary habits. For a new behavior, the main issue is its initiation, and therefore action planning should be the main focus. Ongoing behaviors, in contrast, that become a target for modification first require an accurate monitoring of present action which is part of the action control

construct. Monitoring one's habits generates self-regulatory feedback that may help control goal-directed behavior. It has to be investigated if dietary action control treatments are also beneficial when it comes to improving one's diet.

Aims of the Study

The present study was designed to test the feasibility of a minimal (one-hour) online intervention with a broad reach. Further, it was designed to make a contribution to the understanding of psychological mechanisms that lead to an increase in fruit consumption, because only few studies have demonstrated the antecedents and effects of joint changes in dietary planning and action control (e.g., Scholz et al., 2009).

To improve fruit consumption, we have developed a very brief theory-guided online intervention that was mainly based on two components: developing dietary planning skills and cultivating dietary action control.

The study was designed as a randomized controlled trial to examine the effects of the intervention in comparison to a control group. It was expected that the intervention group not only scores higher in dietary planning and action control, but also reports higher levels of fruit consumption later on.

Moreover, to explain such a desired outcome, the possible gain in fruit intake needed to be traced back to the self-regulatory intervention ingredients, such as dietary planning and action control. Thus, changes in these two variables were specified as mediators between intervention and fruit consumption.

Method

Procedure

We conducted an online intervention designed to promote fruit consumption in Germany. Data collection started in December 2009 and ended in June 2011. Participants were recruited

by press releases (radio, newspaper, TV) and advertisements posted on the university internet site. Initially, 2.306 participants followed the link to the starting web page, and, after giving informed consent, were directed to a baseline questionnaire (Time 1 [T1]). After the baseline questionnaire, the system then randomly allocated individuals to an experimental group or a control group (see Figure 1). As part of the baseline questionnaire, participants were asked for their current fruit intake (in portions per day). One week later (Time 2 [T2]), participants received an email invitation for the follow-up assessment.

A total of 1.154 participants were randomized to either the intervention or the control group. The intervention group received a volitional treatment that lasted on average 45 minutes. The control group received a standard care intervention (see below). A subsample of 791 individuals revisited the website and completed the follow-up assessment (34.3% of initial contacts).

The study adhered to APA ethical principles regarding research with human participants and was approved by the internal review board.

Participants

Inclusion criteria for this study were the completion of both assessments. The final study consisted of 791 individuals who were on average *M* = 37.73 years old (range = 14-79, *SD* = 11.9), and mostly women (79.0%) with an average body mass index of 25.61 (range = 15-66, SD = 5.76). The majority of the sample was well educated (70.3% college degree), employed (64%), and in a steady relationship (64.5%).

The intervention group included 392 individuals compared to 399 in the control group.

Insert Figure 1 about here

Measures

Fruit intake was measured in an open answer format: "Please think of your dietary behavior in the past week: How many servings of fruit (e.g., bananas, apples) did you eat on average per day?" One serving was defined and visualized as the amount that fits in the palm of one's hand.

Dietary planning was measured by two items: "I have already planned precisely (1) in which situations I need to be especially careful so as to succeed in eating sufficient amounts of fruit, and (2) what I can do in difficult situations so as to succeed in eating sufficient amounts of fruit." Statements were rated on a six-point Likert scale ranging from (1) *not at all true* to (6) *exactly true*. Item intercorrelations were high (T1: r =.68, p <.001, T2: r =.76, p <.001), and a sum score was computed.

Dietary action control was measured by three items concerning self-monitoring, awareness of standards, and self-regulatory effort. The items read as follows: (1) "I consistently monitor how many portions of fruit I want to eat throughout the day", (2) "I always check whether I eat exactly as many portions of fruit throughout the day as I have planned", and (3) "I really try hard to eat fruit throughout the day as I have planned." Statements were rated on a six-point Likert scale ranging from (1) *not at all true* to (6) *exactly true*. Cronbach's alpha was .86 at the first and .88 at the second measurement point in time.

All measures had been validated in previous studies (Kreausukon et al., 2012; Luszczynska et al., 2007).

Correlations between dietary planning and dietary action control were .52, p<.01, at T1, and .57, p<.01, at T2.

Intervention and Control Conditions

The study was a two-group randomized controlled trial comparing a brief psychological online intervention with a control condition. All materials were developed using the

Intervention Mapping approach (Bartholomew et al., 2006), as well as based on the taxonomy of behavior change techniques (BCTs) by Abraham and Michie (2008).

It was assumed that voluntary participants of an online intervention fostering fruit consumption are a somewhat higher motivated subpopulation of the general public. We verified this assumption by assessing participants' motivation to enrich their diet with more fruit. On average, they were motivated to increase daily fruit consumption by more than two portions (M=2.62, SD=1.09). Therefore, it was adequate to concentrate on an intervention that focuses on goal pursuit.

Participants in the *experimental group* received an intervention prompting dietary planning and action control. In particular, participants were asked to commit to a specific personal goal with regard to fruit consumption, and to write it down (e.g., to eat five portions of fruit daily by next week). They were then prompted to specify opportunities (where and when) for a smaller initial sub goal, such as one piece of fruit per day by the end of this week. If participants' higher order goal was rather simple, they specified opportunities for that instead. Additionally, they were asked to identify opportunities for preparatory behaviors (such as buying and preparing food) and to enter it into a calendar that they could print if desired. Participants were encouraged to gain experience with their planned behavior and then to review and potentially revise their self-imposed goals (blank calendars were provided). In brief written vignettes, role models identified five common situations that may pose a challenge and provided solutions to overcome these obstacles. Subsequently, participants were prompted to identify up to three personal barriers and to find strategies to overcome them.

Individuals in the *control condition* received a knowledge-based quiz on nutrition that was comparable in modes of delivery (internet-based texts and pictures) and time (on average 45 minutes). One possible kind of question that was addressed: "Which fruit contains more vitamin C: an orange or a handful of strawberries?"

The intervention manual and all materials can be obtained from the author.

Data Analysis

All analyses were run with SPSS 20. Dropout analyses compared retained participants with those lost after T1 using *t*-tests for continuous measures and χ^2-tests for categorical measures. Randomization checks tested baseline differences between participants in the two study conditions by means of ANOVAs for continuous and χ^2-tests for categorical measures.

To examine *intervention effects*, repeated measures analyses of variance were computed with fruit intake, dietary planning, and dietary action control as dependent variables at two points in time and groups as the between-subjects factor.

To examine *mediator effects*, multiple mediation analyses were computed using the SPSS macro "Indirect" that includes multiple regression procedures with bootstrapping (Hayes, 2009). Mediation exists when a predictor affects a dependent variable indirectly through at least one intervening variable (mediator) (Preacher & Hayes, 2008). Change scores (Time 2 minus Time 1) of dietary planning and action control served as mediators. As exploratory analyses had determined that body mass index and age were unrelated to the outcome, only baseline fruit consumption and sex were chosen as control factors.

Results

Drop-out analyses

Results indicated that individuals who continued study participation were more likely female ($\chi 2 = 17.1$, $p < .001$), with a higher level of education ($\chi 2 = 13.2$, $p < .05$), a lower body mass index ($t = 2.96$, $p < .01$), and a slightly higher base level of dietary planning ($t = 2.35$, $p < .05$). Besides that, no other differences were significant with regard to treatment condition, fruit intake, motivation to eat more fruit, dietary action control, and socio-demographic variables (all $p > .05$).

Randomization check

Results revealed no baseline differences across the two study conditions regarding fruit intake, motivation to eat more fruit, social-cognitive variables (i.e., dietary planning and action control), and socio-demographic variables (all $p > .05$), indicating a successful randomization procedure.

Intervention effects

Means, standard deviations, and group comparison statistics for all variables are summarized in Table 1.

Insert Table 1 about here

To examine the intervention effects at posttest, repeated measures ANOVAs were computed.

For the dependent variable *fruit consumption*, a main effect for time emerged, $F(1,784) = 263.70$, $p < .001$, $\eta^2 = .25$, but not for the intervention group, $F(1,784) = 2.35$, $p > .05$. There was also an interaction between group and time, $F(1,784) = 9.69$, $p < .01$, $\eta^2 = .01$, (see Figure 2a).

For the dependent variable *dietary action control*, a main effect for time emerged, $F(1,777) = 347.89$, $p < .001$, $\eta^2 = .31$, as well as a main effect for group, $F(1,777) = 13.24$, $p < .001$, $\eta^2 = .02$, and an interaction between group and time, $F(1,777) = 12.49$, $p < .001$, $\eta^2 = .02$, (see Figure 2b).

For the dependent variable *dietary planning*, a main effect for time emerged, $F(1,782) = 146.22$, $p < .001$, $\eta^2 = .16$, but there was no main effect for group, $F(1,782) = .87$, $p > .05$. Nonetheless, an interaction between group and time emerged, $F(1,782) = 6.99$, $p < .01$, $\eta^2 = .01$, (see Figure 2c).

Insert Figure 2 about here

Mediation Analyses

So far, it has been documented that there were substantial treatment effects on all outcome variables (see d values in Table 1). The following analysis addresses the question of whether the key intervention ingredients, dietary planning and action control were instrumental in the change of fruit consumption. For this purpose, changes in dietary planning and action control were considered to serve as putative mediators between the interventions and the primary behavioral outcome, fruit consumption. Mediation analyses, controlling for demographics and baseline behavior, were conducted. Beforehand, it was examined whether the two putative mediators were overlapping constructs. The intercorrelation between dietary planning change and action control change was r=.35, p<.01, confirming the discriminant validity of these constructs.

Experimental conditions predicted dietary planning, β = .24, p < .01, and action control, β = .30, p < .001, and subsequently, T2 fruit consumption was predicted by these two mediators, dietary planning, β = .08, p < .001, and action control, β = .16, p < .001, controlling for sex, β = -.16, p > .05, and baseline fruit consumption, β = .61, p < .001. The total effect of the intervention is .20, including indirect effects of .07. Overall, 23% of the fruit intake variance was accounted for by the entire model (see Figure 3).

Insert Figure 3 about here

Discussion

This study examined whether a very brief online nutrition intervention would make a difference on fruit consumption. Study participants were randomly assigned to a

psychological intervention or control group. The intervention was theory-guided, with a particular focus on dietary planning and action control. Repeated measures analyses comparing these two groups at pretest and posttest yielded significant time by group interactions for all three dependent variables: fruit consumption, dietary planning and action control. It was found that participants receiving the intervention consumed more fruit than participants in the control condition. The same kind of effect emerged for the social-cognitive predictors, namely dietary planning and action control.

A further question was whether these two variables simply constitute multiple outcomes of the intervention, or whether they might reflect the ingredients of the intervention package and would, thus, operate as agents for behavior change. To examine the mechanisms of behavior change we specified a path model where changes in dietary planning and action control served as mediators between experimental conditions and later fruit consumption. Such an analysis is likely to shed light on the way these variables might have operated in the study (Hayes, 2009; Reuter, Ziegelmann, Wiedemann, & Lippke, 2008).

Similar results confirming the role of self-regulatory planning skills have been found in randomized controlled trials, for example by Kellar and Abraham (2005) in England, Guillaumie et al. (2012) in Canada, Kreausukon et al. (2012) in Thailand, and Stadler, Oettingen, and Gollwitzer (2010) in Germany. These studies not only found an increase in fruit consumption in the intervention groups as compared to the control groups but also a variety of mediating mechanisms. The most similar study to the present one is the one by Kreausukon et al. (2012) who selected perceived self-efficacy instead of action control as a mediator, in addition to coping planning. In the study by Guillaumie et al. (2012), coping planning was also identified as a mediator between experimental conditions and fruit consumption, whereas action planning served this function only for vegetable consumption.

The present study adds to the literature mainly by introducing action control changes as a second mediator, and thus, stimulating further research that might enrich the number of

putative mediators. Future research should examine under which circumstances one or the other mediator operates (e.g., self-efficacy, action control, coping planning vs. action planning, social norms) and whether moderating effects can be identified.

There are some limitations. First, although the recruitment strategy was widespread, the study participants might not be representative for a larger population because they were predominantly highly educated and motivated women. Therefore, the results should be generalized with caution, and replication should be attempted in different samples.

Second, although experimental condition by time interactions documented superior treatment effects for the self-regulation group, all participants benefited from the study. There are some possible explanations for this: The participants in the control condition received a standard care intervention, and it was expected that the standard care intervention would cause increases in fruit consumption. However, for the self-regulation intervention we expected the effects to be stronger over and above the standard care intervention, and this is precisely what we found. Moreover, the aim of the present study was, among others, to test the feasibility of a minimal intervention (1-hour) that at the same time has a large reach (online). The time by treatment interaction refers to an overall positive effect of this mini-treatment, although the effect size is small. A question for future research is whether there is a dose-response relationship, i.e., whether a 2-hour, 3-hour, or 10-hour treatment of the same kind leads to larger effect sizes for this interaction. Finally, the time effect, on the other hand, might be due to pretest sensitization, as in the present research design there is no additional control group without pretest.

Third, the intervention package included mainly two components, namely dietary planning and action control. The effects of these two components cannot be disentangled, and one cannot judge whether one of them would have been sufficient to achieve the present results. To identify the specific effects of each of these ingredients, one could design a

randomized controlled trial with more groups, providing interventions with one component only.

Moreover, all assessments were self-reported, and no objective measures were available because the online format of the study. Furthermore fruit intake was measured retrospectively. Retrospective methods are vulnerable to unintentional misreporting (e.g., due to recall errors). One could overcome this limitation by using on-going dietary assessments such as food diaries, where individuals record details of foods at the time of consumption or shortly afterwards (e.g., Kolar et al., 2005). Nevertheless, measurement error depends on the accuracy of the reported intake by the participant in the same way: Individuals may forget to record food items consumed, or to cover up poor eating habits. However, intentional misreporting (owing, e.g., to social desirability) was limited due to the anonymity provided by the internet.

Additionally, we decided to focus on "easy," rather than on "difficult" foods to adopt. More specifically, for most people, it seems easier to increase servings of fruit per day than servings of vegetables (e.g., fruit is an easy snack between meals: it is easy to grab, doesn't need to be cooked, and tastes sweet) (Cox et al., 1998; Guillaumie et al., 2012). In the future, this approach could be extended to other nutrition behaviors, first of all vegetable consumption.

Nevertheless, as most interventions did not allow to precisely identify the behavior change techniques and the psychosocial variables mediating behavior change, the use of a one-hour randomized controlled online trial and the theory-guided intervention design have further elucidated the mechanisms of dietary change processes, using fruit consumption as an example. The findings partly replicate similar studies with different health behaviors and, thus, make a contribution to our cumulative knowledge about self-regulatory components in health behavior changes.

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Table 1

Means and standard deviations (SD) of all study variables in both groups, and comparison between groups.

	Time 1					Time 2				
Variable / Group	M	*SD*	*t*	*p*	d	M	*SD*	*t*	*p*	d
Fruit intake			.24	.81	.03			1.98	< .05	.20
Intervention	1.16	.72				1.90	1.16			
Control	1.18	.72				1.68	.98			
Dietary planning			.80	.42	.01			2.18	< .05	.11
Intervention	2.66	1.10				3.39	1.22			
Control	2.65	1.13				3.26	1.25			
Action control			1.11	.26	.08			2.10	< .05	.22
Intervention	2.66	1.08				3.59	1.15			
Control	2.57	1.06				3.33	1.21			

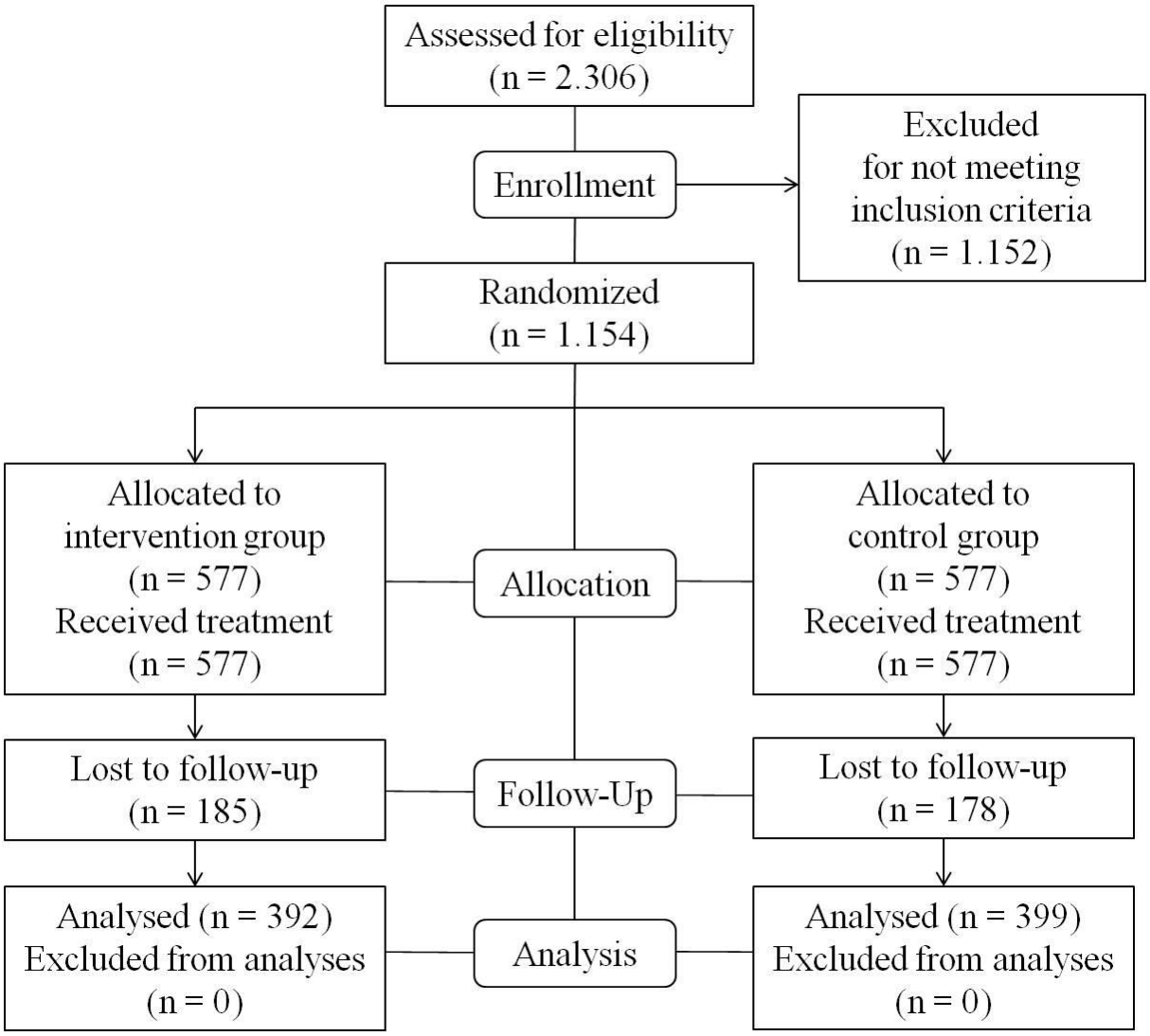

Figure 1. Flowchart with numbers of participants who attended the intervention and control conditions.

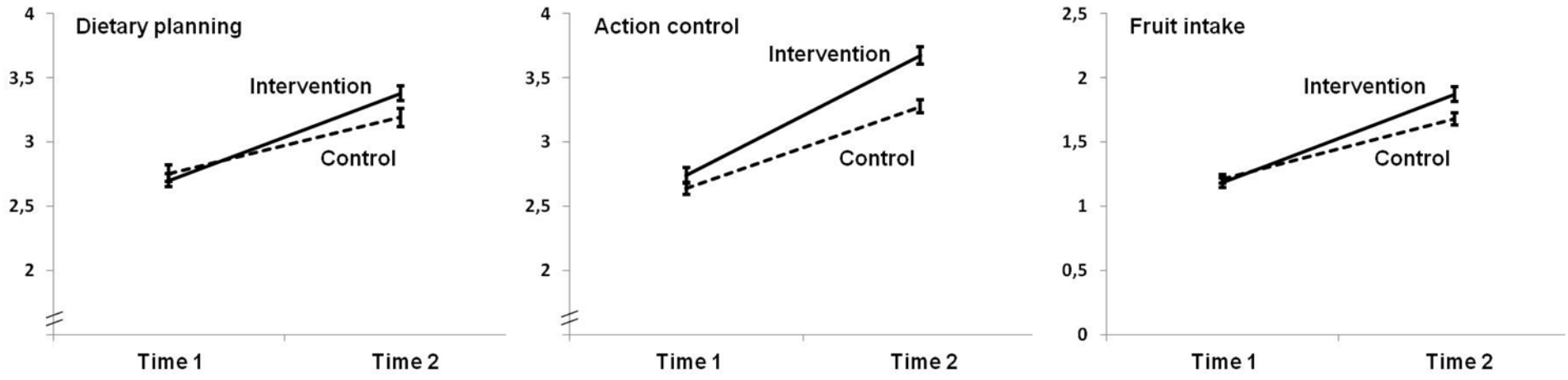

Figure 2. Levels of dietary planning, action control, and fruit intake in the two experimental conditions at two points in time. Error bars represent standard errors.

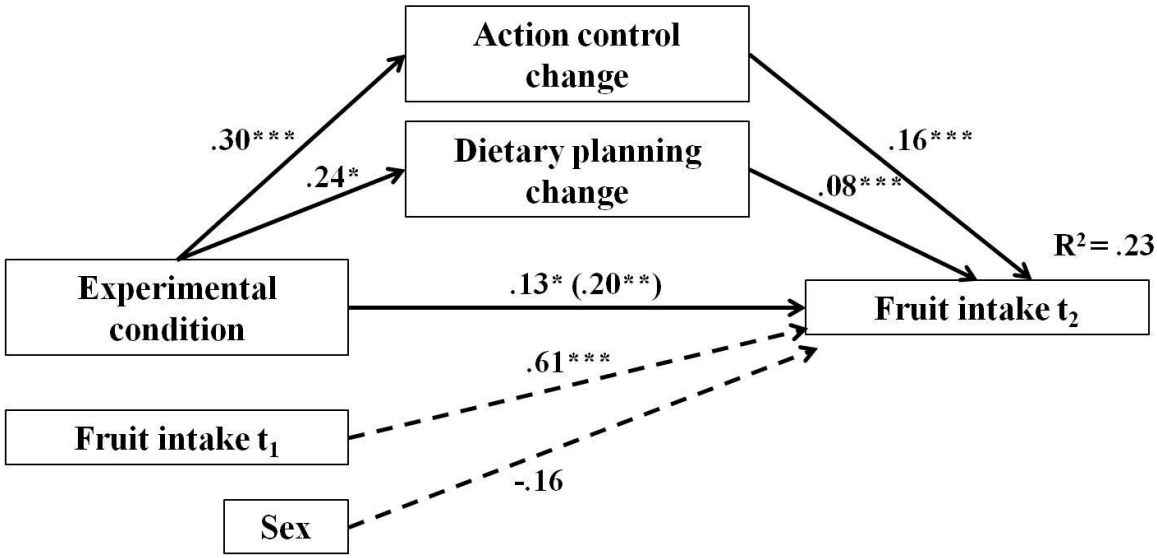

Figure 3. Effects of experimental conditions (1=treatment, 0=control) via two mediators (changes in action control and dietary planning) on fruit intake, with two covariates (sex [1=men, 2=women], and baseline fruit intake).

*p<.05. **p<.01. ***p<.001.