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Motivational Predictors of Weight Loss and Weight-Loss Maintenance

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Self-determination theory proposes that behavior change will occur and persist if it is autonomously motivated. Autonomous motivation for a behavior is theorized to be a function both of individual differences in the autonomy orientation from the General Causality Orientations Scale and of the degree of autonomy supportiveness of relevant social contexts. We tested the theory with 128 patients in a 6-month, very-low-calorie weight-loss program with a 23-month follow-up. Analyses confirmed the predictions that (a) participants whose motivation for weight loss was more autonomous would attend the program more regularly, lose more weight during the program, and evidence greater maintained weight loss at follow-up, and (b) participants' autonomous motivation for weight loss would be predicted both by their autonomy orientation and by the perceived autonomy supportiveness of the interpersonal climate created by the health-care staff.

Recent statistics indicate that more than 12 million American adults are severely obese and face significant health risks due to their weight (Kissebah, Freedman, & Peiris, 1989; Kuczmarski, 1992).[1] In addition to being linked to heart disease, hypertension, diabetes, and various other illnesses, severe obesity has been found, in both longitudinal and actuarial studies, to significantly increase the risk of premature death (Drenick, Bale, & Selzer, 1980; Pi-Sunyer, 1993; Simopoulos & Van Itallie, 1984). Furthermore, in many countries, including the United States, obesity is a stigmatizing condition, especially for women (Sobal & Stunkard, 1989), and is often associated with dysphoric states and psychological problems.

Although there is disagreement about whether or not there are significant risks associated with mild obesity (Garner & Wooley, 1991), there is little doubt about the seriousness of the risks associated with severe and morbid obesity.[2] Consequently, very-low-calorie diets have often been recommended for the severely or morbidly obese. Although such diets can have negative side effects (e.g., Apfelbaum, Fricker, & Igoin-Apfelbaum, 1987), the risks related to severe and morbid obesity are believed to outweigh those related to the diets.

Typically, people who persist at very-low-calorie diets lose large amounts of weight, averaging about 44 lbs (20 kg) in 12-16 weeks (Wadden, 1993). The great majority of these individuals, however, regain a substantial portion of that weight within a relatively short amount of time (e.g., Drenick & Johnson, 1978; Wadden & Stunkard, 1986). Many of them then repeat the process of dieting and regaining weight (Rodin, 1992).

Substantial research has confirmed that people's weight is a complex function of genetic, behavioral, psychological, and environmental factors. A review by Grilo and Pogue-Geile (1991) concluded that although genetic factors account for substantial variation in obesity, considerable variance remains to be explained by behavioral variables, such as eating and exercise, and by their psychological and environmental determinants. The present study concerns those psychological and environmental determinants.

The present study was conducted in a 6-month, medically supervised, very-low-calorie weight-loss program with patients who were severely or morbidly obese. This study was *not* intended to evaluate the effectiveness of the program but rather was designed to predict which people in the program would lose the most weight and would maintain the greatest weight loss over a 2-year period. More specifically, psychological and environmental variables related to patients' motivation were used to predict (a) patients' attendance at weekly meetings of the 6-month, clinic-based program, (b) weight loss during the 6-month period, and both (c) exercise and (d) maintained weight loss at a 23-month follow-up.

Weight-Loss Programs, Weight Loss, and Maintained Weight Loss

Garner and Wooley (1991) concluded that nearly all weight-loss programs are moderately successful in promoting at least

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[1] The most frequently used metric for defining obesity involves calculating body mass index (BMI), which is body weight in kilograms divided by the square of one's height in meters. According to Kuczmarski (1992), the 12 million seriously obese individuals in our culture have a BMI of at least 31.1 (for men) or 32.3 (for women).

[2] *Morbid obesity* is defined as having a body mass index (BMI) in excess of 39. Williamson (1993) reported that there are more than 3 million morbidly obese Americans. Such individuals have a body fat

some weight loss and that the supervised, very-low-calorie programs have particularly positive results for those patients who attend regularly for the specified period. Recent reviews indicate, however, that attrition during the active phase of these very-low-calorie programs, which ranges from 23% to 64%, has been increasing in the last few years (Brownell & Kramer, 1989; Kramer, Jeffery, Forster, & Snell, 1989; Pratt, 1989).

Furthermore, the evidence is quite clear that relatively little of the weight loss accomplished in diet programs is maintained over the long term. Kramer et al. (1989) reported that less than 3% of the patients in one program had maintained their full losses over a 4-year period, and Stunkard and Penick (1979) reported that the median weight loss from the beginning of a behavior modification program to a 5-year follow-up was only 6 pounds. These statistics are clearly discouraging with respect to the overall efficacy of weight-loss programs, and yet the data also show considerable variability in the amount of weight loss that different individuals are able to maintain.

Various writers concerned with the variability in individuals' success at maintaining weight loss have suggested that motivation is the key to understanding which obese patients will consistently attend weight-loss programs, lose significant amounts of weight, exercise regularly, and maintain their weight loss (Crimmins, 1987; Pratt, 1989; Sobal & Stunkard, 1989). Still, there has been relatively little empirical consideration of these motivational issues within weight-loss programs.

Motivation and the Success of Weight-Loss Programs

The motivational approach most frequently applied in health-care settings is the *health-belief model* (Janz & Becker, 1984; Rosenstock, 1974). Derived from an expectancy-valence framework (Lewin, 1936), recent formulations of the model (e.g., Taylor, 1990) incorporate the concepts of locus of control (Rotter, 1966) and self-efficacy (Bandura, 1977). When applied to weight loss, the theory suggests that people will be motivated to lose weight if: (a) they believe that weight loss will decrease their likelihood of contracting a life-threatening illness, (b) they have an internal locus of control and expect that specific behaviors such as reduced calorie intake and exercise will yield significant weight loss, and (c) they are confident that they are able to perform the requisite behaviors.

Although there is some indication that the components of this model, such as an internal locus of control (Rotter, 1966) and self-efficacy (Bandura, 1977), may be related to weight loss (e.g., Brownell, Marlatt, Lichtenstein, & Wilson, 1986; Kincey, 1981), the research results have been mixed, and there is no clear evidence that locus of control or other components of the health-belief model reliably predict maintained weight loss over a reasonable period of time.

Deci and Ryan (1985b) suggested that, although valuing an outcome (such as weight loss) and feeling able to attain that outcome promote motivation, it is important to distinguish between two types of motivation—namely, autonomous and controlled—to predict long-term maintenance of motivated behavior change. According to self-determination theory (Deci & Ryan, 1985b), *autonomous* behaviors are ones for which the regulation is experienced as chosen and as emanating from one's self, in other words, as having an internal perceived locus of causality (deCharms, 1968). In contrast, *controlled* behaviors are ones for which the regulation is experienced as pressured or coerced by some interpersonal or intrapsychic force (they have an external perceived locus of causality).

Considerable research now attests to the qualitative advantages of autonomous, relative to controlled, behavior. For example, autonomous behavior has been associated with more positive mental health (Kasser & Ryan, 1993), better adjustment (Deci, Schwartz, Sheinman, & Ryan, 1981), greater cognitive flexibility (Grolnick & Ryan, 1987; McGraw & McCullers, 1979), and enhanced creativity (Amabile, 1983).

Concerning weight loss, self-determination theory (Deci & Ryan, 1985b) suggests that the lasting behavior change necessary for maintenance depends not on complying with demands for change but rather on accepting the regulation for change as one's own. In other words, it requires internalizing values and regulation of relevant behaviors and then integrating them with one's sense of self so they can become the basis for autonomous regulation. Thus, according to the theory, successful weight loss and long-term maintenance would *not* result from dieting if the reasons for dieting were controlling (e.g., because your spouse insisted, or because you would feel guilty if you didn't). Such controlling reasons indicate that the perceived locus of causality is external, that the individual has not personally endorsed the behaviors and developed a genuine willingness to do them. Instead, successful, maintained weight reduction is theorized to result from people's dieting because they personally value weight loss and its health benefits. People's behavior change will be maintained, the theory asserts, when the reasons for action are truly their own, when people are acting with an internal perceived locus of causality.

In considering these issues, it is essential to keep clear the important difference between the concepts of locus of *control* and locus of *causality*. *Locus of control* (Rotter, 1966) refers to people's expectations about whether or not their behaviors are reliably linked to outcomes—an internal locus of control is the belief that they are, and an external locus of control is the belief that they are not. In contrast, *locus of causality* (deCharms, 1968; Deci & Ryan, 1985b) refers to whether the perceived source of initiation and regulation for motivated behaviors are within one's self (in which case the behaviors are autonomous) or are outside one's self (in which case the behaviors are controlled). Thus, a person with an internal locus of control could have either an internal locus of causality or an external locus of causality for some activity (such as participating in a weight-loss program). We assert that being autonomous in one's relevant actions—that is, having an internal locus of *causality*, in contrast to an internal locus of *control*—is the crucial predictor of maintained behavior change.

Several domain-specific questionnaires have been developed to assess the extent to which people's reasons for participating in some activity are relatively autonomous or relatively controlled. The initial questionnaires were developed to assess children's reasons for participating in academic and prosocial activities (Ryan & Connell, 1989), and subsequent adaptations have been used in

content of 50%–75% of total weight, compared with 15%–25% in nonobese people (Van Itallie & Kral, 1981).

the study of religion (Ryan, Rigby, & King, 1993), relationships (Blais, Sabourin, Boucher, & Vallerand, 1990), and health care (e.g., Ryan, Plant, & O'Malley, 1995).

The present study of patients in a clinic-based, very-low-calorie weight-loss program for the severely and morbidly obese was designed in part to test the hypotheses that dieters who report stronger autonomous reasons for their participation in the program would (a) attend more regularly, (b) lose more weight, (c) maintain an exercise regimen, and (d) evidence greater maintained weight loss at a 23-month follow-up.

According to self-determination theory, whether people will be autonomous in regulating a behavior or class of behaviors (such as participating in an aggressive dieting program) can be predicted both from individual-difference and from social-context variables. Specifically, the concept of *general causality orientations* (Deci & Ryan, 1985a) assesses three relatively enduring, individual differences in general orientations toward the regulation of behavior: namely, the autonomy, control, and impersonal orientations. The *autonomy orientation,* which is the one focused on in this research, describes the general tendency to be self-regulating and to orient toward contextual factors that promote choice and individual initiative. Past research has revealed that the autonomy orientation has been positively related to a variety of psychological traits, including self-esteem, self-actualization, and ego development (Deci & Ryan, 1985a), as well as to greater integration in personality (Koestner, Bernieri, & Zuckerman, 1992). The autonomy orientation has also predicted cardiac surgery patients' viewing their surgery more as a challenge than a threat and having more positive postoperative attitudes (King, 1984).

In the present study, we hypothesized that the general autonomy orientation would predict people's being more self-determined in their reasons for participating in the weight-loss program, which would in turn, we hypothesized, predict the four previously mentioned behavioral and weight-loss variables.

Self-determination theory also suggests that *autonomy-supportive contexts*—ones in which significant others offer choice, provide a meaningful rationale, minimize pressure, and acknowledge the target individual's feelings and perspectives—will facilitate internalization and integration of regulatory processes and thus promote effective, long-term behavior change.

Past research, for example, has revealed that when individuals perceive their environment to be more autonomy supportive, they tend to show enhanced self-initiation and autonomous regulation (Deci & Ryan, 1987, 1991). For example, Ryan and Grolnick (1986) found that students who perceived their teachers as more autonomy supportive were more mastery motivated and had greater perceived competence than students who perceived their teachers as more controlling. Similarly, Grolnick, Ryan, and Deci (1991) showed that children who perceived their parents as more autonomy supportive displayed enhanced internalization of academic self-regulation and achieved better grades. Furthermore, in a laboratory experiment by Deci, Eghrari, Patrick, and Leone (1994), autonomy support (as operationalized by minimized control, a meaningful rationale, and acknowledging feelings) led to greater persistence at the target behavior in a subsequent period and to more positive affect.

Consequently, we hypothesized that participants who perceived the interpersonal climate of their weight-loss program as more autonomy supportive would report more autonomous reasons for their ongoing involvement in the program, which in turn would yield more positive outcomes.

In this study, we also assessed patients' health locus of control (Wallston & Wallston, 1978), because the measure has been widely used, and the concept is integral to the health-belief model. We made no predictions about that measure, however, because, as we have argued, a person with an internal locus of control can be motivated in either an autonomous or a controlled manner, and it is the autonomy variable that we theorize to be the more important predictor of maintained behavior change.

Method

Description of the Program

Before beginning this 26-week program, severely obese patients were given a health assessment and brief psychological interview by program staff. During the first 13 weeks of the program, they used the very-low-calorie liquid diet, and then normal foods were gradually reinstated at a restricted level. Patients' weights, vital signs, and laboratory tests were checked weekly by a nurse or physician, and patients attended a weekly group meeting with approximately 12–15 other patients led by a psychologist. The intent of these meetings was to foster peer support, to facilitate discussions of feelings and difficulties, and to provide techniques for self-monitoring relevant behaviors. Also at these weekly meetings, nutritionists and exercise physiologists gave mini-lectures and consultations.

Time Frame and Participants

Participants were 128 severely obese individuals who enrolled in the Optifast weight loss program at a community hospital affiliated with a university medical center. The average age of the participants was 43 years, and 73% of them were female. The schedule for key program events, the times of assessments, and the number of participants providing data at each time were as follows:

Time 1 (T1): Before the first program meeting, participants completed the General Causality Orientations Scale (GCOS) and the Health Locus of Control Scale (HLOC). Participants' weights and heights were recorded by a nurse at the program center. All 128 participants completed the GCOS, and 124 completed all items on the HLOC.

Time 2 (T2): Five to ten weeks into the program, participants completed the Health Care Climate Questionnaire (HCCQ), which assessed their perceptions of the autonomy supportiveness of the staff, and the Treatment Self-Regulation Questionnaire (TSRQ), which assessed their reasons for participating in the program and following its guidelines. If they dropped out of the Optifast program prior to this time, they were asked to complete the HCCQ at the time they dropped out, but they were not asked to complete the TSRQ, because it concerns why participants are continuing to be involved in the program. The HCCQ was completed by 103 participants and the TSRQ by 94 participants. The remaining participants failed to return the TSRQ despite repeated requests.

Because the hypotheses all involve the autonomous-reasons variable assessed with the TSRQ, all the primary LISREL and regression analyses employed these 94 participants. To ascertain whether those who did not return the TSRQ were different from those who did return the questionnaire, the two groups were compared on several relevant variables. The two groups did not differ significantly on the baseline measures of age (Cohen's $d = .09$), gender ($d = .42$), autonomy orientation ($d =$

.43), and starting body mass index (BMI;[1] $d = .36$). All of these effect sizes were small to medium (Rosenthal & Rosnow, 1991).

Time 3 (T3): At the end of the 6-month program, participants were weighed at the program center, and their final BMI was calculated. Of the 94 participants included in the primary analyses, 10 had dropped out of the program before the 26th week. For these participants, we used their weight at their last date of attendance to calculate their final BMI. This seemed not only reasonable but also conservative, for the following reason: The liquid Optifast diet was used for the first 13 weeks of the program, and then patients gradually shifted back to food. All patients lost weight during the 13 weeks, and then all patients gradually gained back some of their weight during the next 13 weeks as they were eating regular food. Of the 10 patients who dropped out of the program (from the sample of 94 used in the primary analyses), 1 dropped out after 11 weeks, 1 after 13 weeks, and the rest stayed at least 15 weeks. Thus, the patients who dropped out were all at (or virtually at) the phase at which they were beginning to gain weight, so their 6-month weight loss was almost certainly less than that which was recorded for them. This is an important point, because patients who dropped out did, as we would expect, have lower scores than those who completed the program on some relevant motivation predictor variables, namely autonomy orientation, $t(92) = 2.31, p < .03$, and internal health locus of control, $t(92) = 1.96, p < .06$, so using the weight loss calculated at the point of last attendance (which was almost certainly higher than the actual 6-month weight loss) would work against our hypotheses, thus making the tests more conservative.

Time 4 (T4): Starting at 20 months after a patient entered the program, attempts were made to contact him or her by telephone to request participation in the follow-up (which participants had agreed to in their initial consent). If participants could not be reached by phone, a cover letter and questionnaire were sent to the last address in their program records. If there was no response to this mailing, a second mailing was done 1 month later. Participants were asked to complete the TSRQ (addressing reasons for following the Optifast guidelines), to provide information about their exercise habits and to be weighed at a university health service location or at the Optifast location (whichever was more convenient). If participants were not willing to come in to be weighed, they were asked to self-report their weight. Participants were given a $5 honorarium for taking part in the follow-up.

Of the 128 participants, 3 moved out of the area, 4 had medical reasons for not participating, 4 who were contacted refused to participate, 9 who were contacted said they would participate but did not in spite of repeated contacts, and 50 could not be contacted by phone and did not respond to either mailing. Six participants completed the follow-up (T4) questionnaire but were unwilling to provide weights, so they could not be included in the primary analyses. Thus, there were 52 participants who provided final weights and were the primary sample for testing the maintenance hypotheses. Of these, 8 came in to be weighed, and 44 provided weights over the phone.[3] Furthermore, of the 52 patients, 42 had completed the program, whereas 10 had not, and 40 completed the follow-up questionnaire. Follow-up data from the participants were collected anywhere between 20.4 and 25.9 months after they entered the program ($M = 23$ months).

Because only 52 participants provided follow-up weights, we compared them on several variables with the 76 who did not, to ascertain whether the two groups differed in relevant ways. These analyses indicated that patients for whom we had follow-up weights were significantly older than those for whom we did not (means of 46.0 years vs. 41.6 years, respectively). However, there were no significant differences between the two groups on gender (Cohen's $d = .02$), the autonomy orientation score of the GCOS ($d = .19$), the starting BMI ($d = .22$), the number of weeks of attendance ($d = .13$), program completion ($d = .02$), or change in BMI during the 6-month program ($d = .03$). All of these effect sizes are considered small (Rosenthal & Rosnow, 1991). Thus, the participants who completed the follow-up do not seem meaningfully different from those who did not participate.

Instruments

GCOS. The GCOS (Deci & Ryan, 1985a) consists of 12 vignettes describing typical achievement or social situations (e.g., applying for a job, relating to a friend). Each vignette has three possible responses, one representing each of the three subscales—namely, autonomy, control, and impersonal orientations. Participants rate each response on a 7-point Likert-type scale in terms of how likely it is that they would respond in that way. Higher scores indicate higher amounts of the particular orientation represented by the response. There are a total of 36 items, 12 items per subscale, with each subscale scored independently. The scale has been shown to be reliable, with a Cronbach's alpha of .74 and a test–retest coefficient of .74 over 2 months, and to correlate as expected with a variety of theoretically related constructs (Deci & Ryan, 1985a). In this study, we made hypotheses only about the autonomy orientation, so only those scores were used.

HLOC. The HLOC (Wallston & Wallston, 1978) has three subscales, each with six items, that assess one's beliefs about the control of important health outcomes. The subscales are: internal (the belief that health outcomes are controlled by one's own behavior), powerful others (the belief that health-care providers control one's health outcomes), and chance externality (the belief that health outcomes are random occurrences). Respondents indicate, on a 6-point Likert-type scale, their level of endorsement of statements regarding these three beliefs about control of health outcomes. Subscale scores are calculated by summing the participant's six responses on items corresponding to each subscale. Validity and reliability of this widely used scale can be found in Wallston and Wallston (1978).

TSRQ. This questionnaire was designed to assess reasons for staying in the weight-loss program and following its guidelines (T2) or for continuing to follow the guidelines of the program (T4), using the same format at each time. It was patterned after the self-regulation questionnaires introduced by Ryan and Connell (1989) and adapted from a treatment motivation questionnaire used by Ryan et al. (1995) to study participation in an alcohol treatment program. The TSRQ was written to assess patients' autonomous reasons and their controlled reasons for participation in the program. The TSRQ presents participants with item stems such as: "I am staying in the weight-loss program because . . ." (T2) or "I have been following the guidelines of the program because . . ." (T4), and the stems are followed by several reasons that vary in the extent to which they represent autonomous regulation. Examples of more controlled reasons are: "I want others to see that I am really trying to lose weight" and "I'll feel like a failure if I don't." Examples of more autonomous reasons are: "It's important to me personally to succeed in losing weight" and "I believe it's the best way to help myself." Each reason was rated on a 5-point scale ranging from *not true at all* to *very true.* Factor analysis of the TSRQ on the sample of partici-

[3] Several studies have suggested that self-reports of weight by obese individuals are reliable indicators of actual weight, but that they tend to be underestimates by an average of approximately 5 lbs. (2.25 kg; e.g., Murphy, Bruce, & Williamson, 1985; Stunkard & Albaum, 1981). Because the present study was correlational and not an evaluation of a weight-loss program, it seemed unlikely that the slight underestimates would influence the results. Nonetheless, after completing all the analyses, we added 5 lbs. to each of the self-reported follow-up weights (a procedure also used by Kramer et al., 1989) and repeated all of the analyses. There were no differences in results with or without the 5-lb. additions, and no correlation changed by an amount more than .02.

pants who completed the questionnaire at Time 2, as for other samples who had completed this questionnaire, revealed two clear factors, labeled *Controlled Reasons* and *Autonomous Reasons*. Six items represent controlling reasons, and three items represent autonomous reasons.

HCCQ. We developed the HCCQ on the basis of prior work with similar questionnaires in non-health-care settings (e.g., Deci, Connell, & Ryan, 1989; Grolnick et al., 1991). This 15-item scale assesses participants' perceptions of the degree of autonomy support (vs. controllingness) of the relevant health-care providers. It includes items such as "I feel that the staff has provided me with choices and options." Answers are rated on a 5-point scale ranging from *not true at all* to *very true*. The HCCQ has an alpha of .95 based on a sample of 276 patients who visited a Rochester-area internal medicine office. Factor analysis of their responses revealed a one-factor solution measuring perceived autonomy support.

Exercise measures. Participants were asked three questions (Washburn, Adams, & Haile, 1987; Washburn & Montoye, 1986) assessing (a) how active they perceive themselves to be relative to other people of similar age and sex, with responses on a 5-point scale ranging from *much less* to *much more;* (b) participation in aerobic exercise (to make this dichotomous-response item comparable to the other two items, a "no" response was given a value of 1, and a "yes" was given a value of 5); and (c) frequency of exercise, with responses on a 5-point scale ranging from *less than once per week*, to *seven times per week*. Scores for the three items were summed to form an exercise index with higher scores reflecting more exercise.

Results

Descriptive Statistics

Table 1 presents the means and standard deviations of each variable for the participants who provided data on that variable. Patients ranged in age from 20 to 77 years, with an average of 43. The average starting BMI was 41.0 kg/m^2, with a range from 30.6 to 68.9. Participants attended an average of 20.4 of the weekly sessions with a range of 4–26 weeks. The mean final BMI at the end of the 6-month program was 32.8, with a range of 21.8–53.2. The mean change in BMI was 8.2, which represents a reduction of 20% of the average starting BMI.

The mean follow-up BMI for the 52 participants was 35.0 kg/m^2, yielding a net mean reduction in BMI for these patients of 5.0 kg/m^2 over the 23-month period. The range in the 23-month BMI change was from a reduction of 24.7 kg/m^2 to a gain of 5.3 kg/m^2.

Because body mass index is a difficult concept, we offer two illustrative examples. One 5'6" participant weighing 246 lbs (111 kg; BMI = 43.7 kg/m^2) completed the program weighing 189 lbs (85 kg, BMI = 33.6 kg/m^2). This person lost 57 lbs (26 kg; change in BMI = 10.1 kg/m^2). At 23-month follow-up this participant weighed 236 lbs (106 kg). Follow-up BMI = 41.9, for a maintained weight loss of 10 lbs (4.5 kg), and a follow-up change in BMI of 1.8. Another patient weighed 267 lbs (120 kg) at the start (5'9", BMI = 39.5) and lost 69 lbs (31 kg; final BMI = 29.3) in the program. This patient weighed 235 lbs (106 kg) at the 23-month follow-up (BMI = 34.7).

Internal Structure of Questionnaires

We performed a principal-components factor analysis with varimax rotation on the nine items of the TSRQ answered by

Table 1
Means, Standard Deviations, Ranges, and Sample Sizes for Each Variable in the Study

Variable	*M*	*SD*	min	max	*n*
Time 1					
Age (years)	43.4	11.8	20.0	77.0	128
Autonomy orientation (GCOS)	58.7	6.9	33.0	70.0	128
Internal (HLOC)	27.6	3.9	17.0	36.0	125
Powerful others (HLOC)	15.8	5.8	6.0	36.0	125
Chance (HLOC)	14.6	4.6	6.0	26.0	124
Starting BMI	41.0	7.3	30.6	68.9	128
Time 2					
Autonomy support (HCCQ)	66.5	12.0	21.3	80.0	103
Autonomous T2 (TSRQ)	13.8	1.5	7.0	15.0	94
Controlled T2 (TSRQ)	16.1	5.7	7.0	31.0	94
Time 3					
Attendance (weeks)	20.4	5.2	4.0	26.0	128
Final BMI	32.8	6.4	21.8	53.2	128
Time 4					
Follow-up time (months)	22.8	1.5	20.4	25.9	52
Autonomous T4 (TSRQ)	12.1	2.4	7.0	15.0	44
Controlled T4 (TSRQ)	19.4	5.8	8.0	33.0	43
Exercise follow-up	10.1	3.3	3.0	15.0	46
Follow-up BMI	35.0	6.5	22.9	48.5	52
Change scores					
Δ change in BMI during program (T1–T3)	8.2[a]	3.6	2.4	17.4	128
Δ follow-up change in BMI (T1–T4)	5.0[a]	6.4	−5.3	24.7	52

Note. min = minimum; max = maximum; GCOS = General Causality Orientations Scale; HLOC = Health Locus of Control Scale; BMI = body mass index (kg/m^2); T2 = Time 2; TSRQ = Treatment Self-Regulation Questionnaire; T4 = Time 4; HCCQ = Health Care Climate Questionnaire.
[a] The median change in BMI from Time 1 to Time 3 was 7.0, and the median change in BMI from Time 1 to Time 4 was 3.0.

the 94 participants at T2. Two clear factors were found. The first factor, called *Controlled T2,* contained six items (eigenvalue = 3.21) representing controlled reasons for continuing in the program and following the guidelines. The second factor, called *Autonomous T2,* contained three items (eigenvalue = 1.84) representing autonomous reasons for continuing in the program and following the guidelines. All item loadings were greater than .50 on their primary factor, with no cross-loadings greater than .24.

We conducted a second principal-components factor analysis for the 103 participants who completed the HCCQ. It yielded a single, 15-item factor solution representing autonomy support (eigenvalue = 9.87). All factor loadings were greater than .55.

We computed Cronbach's alphas as a measure of internal consistency. On the TSRQ, these values were: Controlled T2 = .79 and Autonomous T2 = .58; on the HCCQ, the alpha for autonomy support was .96. In subsequent analyses we used the composite scores.

Correlations

Independent variables. Table 2 presents the correlations among the independent variables. The correlations of Autonomous Reasons T2, Controlled Reasons T2, and perceived autonomy support with the other variables represent evidence concerning the construct validity of the TSRQ and HCCQ. As expected, Autonomous T2 was significantly correlated with the Autonomy Orientation score of the GCOS ($r = .38$, $p < .001$) and perceived autonomy support from the HCCQ ($r = .38$, $p < .001$). Thus, both the patients' individual differences in autonomy orientation and their perceptions of the autonomy support in the treatment context related to their autonomous reasons for staying in the program and following its guidelines. Controlled T2 was not significantly correlated with any of the independent variables. Perceived autonomy support (HCCQ) was significantly correlated with autonomy orientation ($r = .28$, $p < .01$), powerful others (HLOC) ($r = .22$, $p < .05$), and age ($r = .32$, $p < .001$). Because gender was uncorrelated with any independent variable, it does not appear in Table 2.

Dependent variables. Table 3 presents the correlations among the six dependent variables: *attendance,* which is the number of weekly meetings the patient attended during the program; *final BMI,* which is the weight on the last day of attendance; *change in BMI,* which is the change in body mass index from the beginning (T1) to the last day of attendance (T3); *exercise follow-up,* which is the amount of exercising at the time of the 23-month follow-up (T4); *follow-up BMI,* which is the BMI at the 23-month follow-up; and *follow-up change in BMI,* which is the difference between follow-up BMI (T4) and starting BMI (T1). Note that the calculation of the two change scores for BMI were done so that a positive value indicates a reduction in BMI and thus a loss of weight. Attendance was significantly correlated with final BMI ($r = .18$, $p < .05$), change in BMI ($r = .55$, $p < .001$), and follow-up change in BMI ($r = .33$, $p < .05$). Final BMI was strongly correlated with follow-up BMI ($r = .69$, $p < .001$) and marginally with follow-up change in BMI ($r = .26$, $p < .10$). Change in BMI was strongly correlated with follow-up change in BMI ($r = .63$, $p < .001$). Exercise follow-up was correlated with follow-up BMI ($r = -.40$, $p < .01$) and with follow-up change in BMI ($r = .42$, $p < .01$). Finally, follow-up BMI was correlated with follow-up change in BMI ($r = -.40$, $p < .01$).

Table 2
Correlations Among All Independent Variables, With Sample Size for Each in Parentheses

Variable	1	2	3	4	5	6	7	8	9	10
1. Age (years)	—	.19** (128)	.09 (125)	.33**** (125)	−.07 (124)	.32**** (103)	.09 (94)	.16 (94)	.11 (44)	−.16 (43)
2. Autonomy orientation (GCOS)		—	.22** (125)	.06 (125)	−.10 (124)	.28*** (103)	.38**** (94)	.03 (94)	.32** (44)	−.25 (43)
3. Internal (HLOC)			—	.17 (124)	−.08 (123)	.07 (101)	.03 (93)	.01 (93)	.11 (44)	.07 (43)
4. Powerful others (HLOC)				—	.11 (123)	.22** (101)	.10 (93)	.04 (93)	−.05 (43)	−.01 (42)
5. Chance (HLOC)					—	−.05 (101)	−.08 (93)	−.05 (93)	.04 (42)	.03 (41)
6. Autonomy support (HCCQ)						—	.38**** (94)	.09 (94)	.54**** (34)	.19 (33)
7. Autonomous T2 (TSRQ)							—	−.11 (94)	.47*** (30)	.05 (29)
8. Controlled T2 (TSRQ)								—	−.24 (30)	.34 (29)
9. Autonomous T4 (TSRQ)									—	.34** (43)
10. Controlled T4 (TSRQ)										—

Note. GCOS = General Causality Orientations Scale; HLOC = Health Locus of Control Scale; T2 = Time 2; TSRQ = Treatment Self-Regulation Questionnaire; T4 = Time 4; HCCQ = Health Care Climate Questionnaire.
** $p < .05$. *** $p < .01$. **** $p < .001$.

Table 3
Correlations Among Dependent Variables, With Sample Sizes in Parentheses

Variable	1	2	3	4	5	6
1. Attendance (weeks)	—	−.18** (128)	.55**** (128)	.10 (46)	−.11 (52)	.33** (52)
2. Final BMI		—	.00 (128)	−.15 (46)	.69**** (52)	.26* (52)
3. Change in BMI			—	.17 (46)	−.10 (52)	.63**** (52)
4. Exercise follow-up				—	−.40*** (37)	.42*** (37)
5. Follow-up change in BMI					—	−.40*** (52)
6. Follow-up BMI						—

Note. BMI = body mass index (kg/m^2).
* $p < .10$. ** $p < .05$. *** $p < .01$. **** $p < .001$.

In the primary analyses of change in this study we used the technique of regressing T1 BMI scores out of T3 BMI scores to calculate change in BMI, and regressing T1 scores out of T4 scores to calculate follow-up change in BMI. This technique avoids problems that can occur when one uses the subtraction method associated with possible differences in the variances of the two measures that go into the change scores (Cohen & Cohen, 1983).

As an initial step before testing the hypotheses, in Table 4 we present the correlation coefficients or betas for the predictor variables with the four primary dependent measures, using the residual method for calculating the two change scores.

Autonomy orientation was significantly related to attendance ($r = .26$, $p < .01$) and to the residual of follow-up BMI ($\beta = -.32$, $p < .05$). Autonomy support was significantly related to attendance ($r = .53$, $p < .001$) and to the residual of final BMI ($\beta = -.09$, $p < .05$). Autonomous Reasons T2 were significantly related to attendance ($r = .34$, $p < .001$), to the residual of final BMI ($\beta = -.11$, $p < .05$), and marginally to the residual of follow-up BMI ($\beta = -.25$, $p < .10$).[4] Controlled T2 was significantly related to the residual of final BMI ($\beta = .10$, $p < .05$). Autonomous Reasons T4 was significantly correlated both with exercise follow-up ($r = .49$, $p < .001$) and with the residual of follow-up BMI ($\beta = -.42$, $p < .001$). Thus, in general, the predictor variables hypothesized to relate to the outcomes did account for significant variance.[5] Furthermore, these analyses indicate that the younger patients tended to lose more weight.

The three subscales of the HLOC failed to relate significantly to any of the dependent variables. The internal subscale (HLOC-I) is the one the theory suggests would predict maintained weight loss, though the beta of −.12 was not significant. Because we hypothesized that the autonomy orientation of the GCOS would be a better predictor of maintenance than would HLOC-I, we performed a hierarchical regression in which follow-up BMI was regressed onto initial BMI to form the residual, then HLOC-I was entered, and finally the autonomy orientation was entered. Results indicated that the internal locus of control did not predict significant variance ($\beta = -.12$) but that the autonomy orientation did predict significant variance over and above that explained by the internal subscale, $\beta = -.31$, $\Delta F(1, 48) = 7.67$, $p < .01$.

Predicting Weight Loss: LISREL Analysis

The self-determination model to be tested for weight loss included the six variables of autonomy orientation (GCOS), autonomy support (HCCQ), Autonomous Reasons T2 (TSRQ), attendance, starting BMI, and final BMI over the 6-month program. Both autonomy orientation and participants' perceptions of the autonomy support of the health-care providers were expected to predict participants' autonomous reasons for continuing to participate in the program. Because participants had been in the program for at least 5 weeks (in most cases, 10 weeks) by the time Autonomous Reasons T2 were assessed, we

[4] We computed correlations of autonomy support and Autonomous Reasons T2 with weight loss at Weeks 5, 6, and 7 to rule out the possibility that patients' perceptions of autonomy support and autonomous motivation for participating in the program simply reflected early success in the program. There were no significant correlations between weight loss at Weeks 5, 6, or 7 and either perceived autonomy support or Autonomous Reasons T2. Indeed, the largest of these six correlations was $r = .08$, *ns*. Early weight loss was, however, correlated with total weight loss (Week 5, $r = .64$; Week 6, $r = .65$; Week 7, $r = .70$, $p < .001$ for each). Thus, although early weight loss contributed to overall weight loss, it did not account for the patients' perceptions of the autonomy supportiveness of the staff or the patients' autonomous motivation for continuing the program.

[5] We repeated these analyses using change scores calculated with the subtraction method rather than the residual method. All results were the same with the following three exceptions: Controlled Reasons T2, which significantly predicted weight loss with the residual method, was not significantly correlated with weight loss with the subtraction method; Autonomous Reasons T2, which marginally predicted maintained weight loss with the residual method, was a significant predictor of maintenance with the subtraction method ($r = .39$, $df = 28$, $p < .05$); and autonomy support, which was insignificantly correlated with maintained weight loss with the residual method, was a significant predictor of maintenance with the subtraction method ($r = .35$, $df = 31$, $p < .05$).

reasoned that the participants would have had enough time in the program for the health-care climate to affect their autonomous reasons to continue. We further hypothesized that participants' autonomous reasons would affect their attendance in the program, which in turn would affect their weight loss over the 6-month period.

Accordingly, to represent the hypotheses in a model, we drew arrows in Figure 1 from both autonomy support and autonomy orientation to Autonomous Reasons T2, then from Autonomous Reasons T2 to attendance, and finally from attendance to final BMI (with starting BMI removed). Because age also was found to relate significantly to the residual of final BMI, we added an arrow to represent this relationship. Because we did not hypothesize that Controlled Reasons T2 would predict weight loss, we did not enter it into the model. (Post hoc analyses revealed that Controlled Reasons did not account for significant variance beyond Autonomous Reasons.)

To assess the fit of the model to the observed data, we calculated the chi-square statistic, the goodness-of fit index (GFI), the delta 2 index, and the Tucker–Lewis Index (TLI). Among this set of statistical indices, the TLI is preferred, because it is relatively stable across small sample sizes such as the one in the current study (Bollen, 1989; Marsh, Balla, & McDonald, 1988).

To assess the strength of the relationship between any two individual variables, we calculated maximum-likelihood parameter estimates. Maximum-likelihood estimators are the most widely used method of obtaining parameter estimates in LISREL path analyses or structural equation modeling, and they are well suited for small sample sizes (Bollen, 1989).

The hypothesized model fit the data well: $\chi^2(9, N = 94) = 6.18, p = .72$; TLI = 1.02; delta 2 = 1.01; and GFI = .98. Figure 2 displays the standardized maximum-likelihood parameter estimates generated for this model. Each hypothesized relationship was supported by a significant parameter estimate. For example, Autonomous Reasons T2 significantly increased attendance (parameter estimate = .34, $p < .05$). The fit of the model, along with the significant parameter estimates for each path, provide support for the hypotheses.

We conducted hierarchical multiple regressions to demonstrate that the relationship of Autonomous Reasons T2 to the residual of final BMI was mediated by attendance. Autonomous Reasons T2 was significantly predictive of final BMI when entered into a regression after controlling for age and starting BMI, $\Delta F(1, 90) = 6.46, p < .01$. When attendance was entered into the equation in the final step, $\Delta F(1, 89) = 25.0, p < .001$, we found that Autonomous Reasons T2 was insignificantly related to the residual of final BMI ($\beta = .04$, *ns*). Thus, the relationships in the LISREL model from Autonomous Reasons T2 to the residual of final BMI was mediated by attendance, even after controlling for age.

Predicting Maintenance

Because of the small number of participants who provided complete data over the 23 months, we could not use LISREL analyses to analyze weight-loss maintenance. Thus, we calculated relations between the residual of follow-up BMI and each variable that might be expected to be a predictor. These correlation coefficients and betas appear in Table 4 for the 52 participants who reported their follow-up BMI. (Sample sizes vary because not all 52 participants had completed the questionnaires at T2 and T4.)

The results show that the residualized follow-up BMI was significantly related to autonomy orientation (GCOS) ($\beta = -.32$, $p < .05$) and to Autonomous Reasons T4 ($\beta = -.42, p < .01$), and was marginally related to Autonomous Reasons T2 ($\beta = -.25, p < .10$). Thus, all of the motivational variables found to be predictive (in the LISREL model) of attendance and the

Table 4
Correlation Coefficients and Betas for Independent Variables With Dependent Variables

	Attendance (weeks)		Residual of final BMI		Exercise follow-up		Residual of follow-up BMI	
Variable	*r*	*n*	*β*	*df*	*r*	*n*	*β*	*df*
Age (years)	.04	128	.09**	2, 125	.05	46	.09	2, 49
Gender (F = 0, M = 1)	.07	128	−.07	2, 125	.09	46	−.10	2, 49
Autonomy orientation (GCOS)	.26***	128	−.05	2, 125	.02	46	−.32**	2, 49
Internal (HLOC)	.02	125	.05	2, 121	−.08	46	−.12	2, 49
Powerful others (HLOC)	.06	125	.06	2, 121	−.07	45	.07	2, 48
Chance (HLOC)	.09	124	.02	2, 121	−.07	44	−.18	2, 47
Autonomy support (HCCQ)	.53****	103	−.09**	2, 100	.24	35	−.07	2, 30
Autonomous T2 (TSRQ)	.34****	94	−.11**	2, 91	.26	31	−.25*	2, 27
Controlled T2 (TSRQ)	−.02	94	.10**	2, 91	−.03	31	.08	2, 27
Autonomous T4 (TSRQ)	NA		NA		.49****	44	−.42****	2, 32
Controlled T4 (TSRQ)	NA		NA		.24	43	−.02	2, 31
Exercise follow-up	NA		NA		1.00		−.37***	2, 34
Attendance	1.00		−.28***	2, 126	.10	46	−.23**	2, 49

Note. BMI = body mass index; F = female; M = male; GCOS = General Causality Orientations Scale; HLOC = Health Locus of Control Scale; HCCQ = Health Care Climate Questionnaire; T2 = Time 2; TSRQ = Treatment Self-Regulation Questionnaire; T4 = Time 4; NA = not applicable.
* $p < .10$. ** $p < .05$. *** $p < .01$. **** $p < .001$.

residual of final BMI were also significantly predictive of the maintenance of reduced BMI over the 23 months.

As noted above, exercise follow-up was predictive of the residual of follow-up BMI ($\beta = -.37, p < .01$). The only predictor variable related to exercise follow-up was Autonomous Reasons T4 ($r = .49, n = 44, p < .001$). Note, however, that the correlations of both Autonomous Reasons T2 and autonomy support with exercise follow-up were moderate and in the predicted direction but were insignificant because of the small sample size. Age, gender, and the HLOC subscales were not correlated with either the residual of follow-up BMI or exercise follow-up.

Discussion

Autonomous behavior is an expression of one's self and is undertaken with a full sense of choice. It is accompanied by an internal perceived locus of causality (deCharms, 1968) and a sense of true volition (Ryan, 1993). In contrast, controlled behavior, although intentional, has an external perceived locus of causality and is experienced as pressured or coerced. According to self-determination theory (Deci & Ryan, 1985b), behavior change will be maintained to the extent that the behavior is autonomous.

In this study of severely obese patients in a 6-month, Optifast weight-loss program, the degree of patients' autonomous motivation for participating in the program was assessed and found to predict attendance at weekly meetings of the program and weight loss during the period. More important, autonomous motivation for participating also predicted maintenance of weight loss at the 23-month follow-up. Thus, the data confirmed that individuals' autonomous motivation is an important predictor of whether a weight-loss program is likely to be effective not only in promoting weight loss but also, more important, in facilitating its maintenance. Given the serious health risks of severe and morbid obesity, these findings seem to be of considerable significance.

We also tested the theoretical propositions that autonomous motivation for an activity (in this case, for the weight-loss program) could be predicted both from individual differences and from characteristics of relevant social contexts. As hypothesized, the Autonomy Orientation subscale from the GCOS was a significant predictor of patients' reporting more autonomous reasons for engaging in the diet program and following its guidelines. Furthermore, the degree to which patients experienced the staff as autonomy supportive was also a significant positive predictor of autonomous reasons for persisting in the program. Although the former finding is certainly of interest, the latter is of greater practical significance, for it suggests that the interpersonal climate created by the health-care staff of a weight loss program will influence the relative autonomy of patients' motivation, which in turn will affect both their weight loss during the program and their maintenance of those losses.

To organize the predictions and results, we used LISREL to test a path model of reduction in BMI. We hypothesized that individual differences in patients' autonomy orientation (GCOS) and their perceptions of the autonomy support from the program staff (HCCQ) would both predict autonomous reasons for participating in the program (TSRQ). We also hypothesized that autonomous reasons, in turn, would predict attendance at program meet-

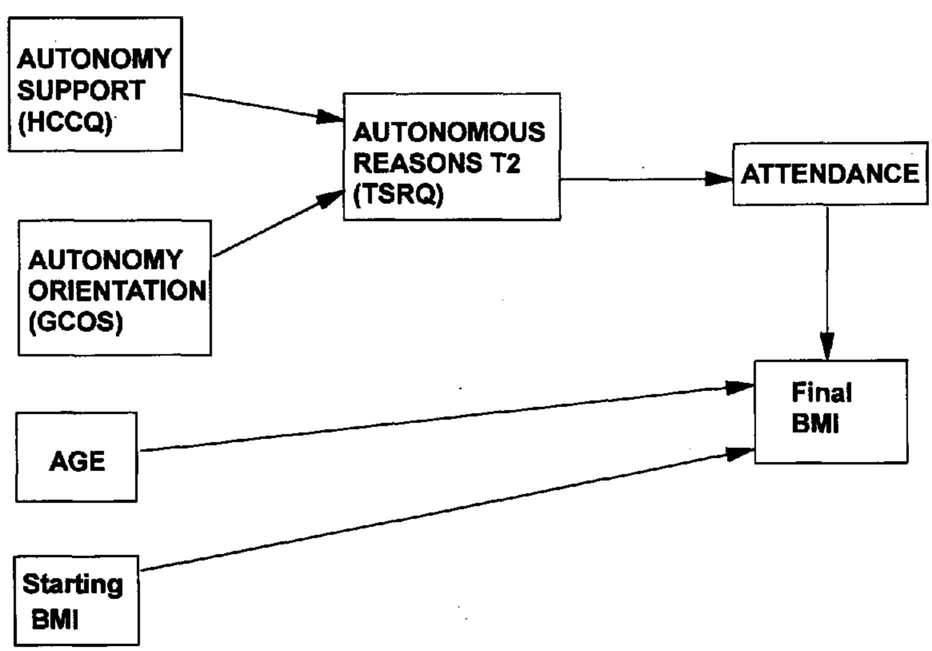

Figure 1. Hypothesized motivational model of weight loss, derived from self-determination theory. HCCQ = Health Care Climate Questionnaire; T2 = Time 2; TSRQ = Treatment Self-Regulation Questionnaire; GCOS = General Causality Orientations Scale; BMI = body mass index.

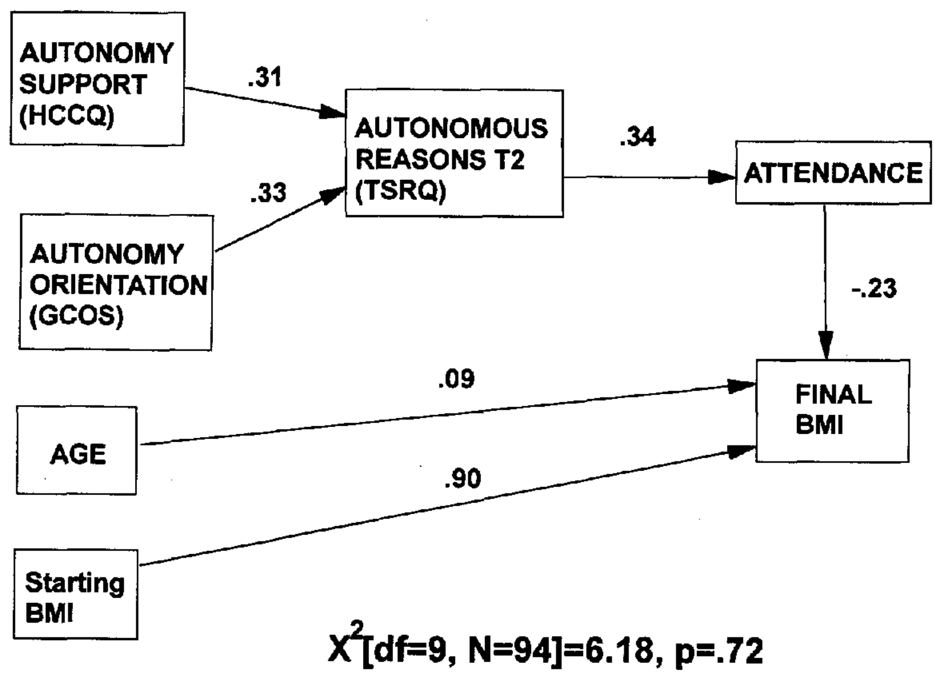

Figure 2. Parameter estimates from LISREL path analysis of the self-determination model of weight loss. HCCQ = Health Care Climate Questionnaire; T2 = Time 2; TSRQ = Treatment Self-Regulation Questionnaire; GCOS = General Causality Orientations Scale; BMI = body mass index.

ings and reduction in BMI. We found that the model fit the data well, and we found that the relation between autonomous reasons for participation and the amount of weight lost were mediated by attendance at the weekly program meetings. Thus, the findings from this study provide clear support for the application of self-determination theory to the problem of weight loss and its maintenance.

To compare the locus of *causality* approach contained within self-determination theory to the widely used locus of *control* approach, we administered the HLOC (Wallston & Wallston, 1978). The results yielded no evidence that health locus of control was predictive of weight loss or weight-loss maintenance. In fact, none of the three subscales of the HLOC related significantly to any of the four outcome variables. The absence of effects for HLOC is readily explicable within self-determination theory. As noted, an internal locus of control (Rotter, 1966) refers to people's beliefs that their behaviors are reliably linked to outcomes. People with an internal locus of control could, however, be autonomous or controlled in regulating their program participation, and we theorize that only people who are relatively autonomous in their motivation to lose weight would be successful in their attempts to do so (e.g., Deci & Ryan, 1985b; Ryan, Deci, & Grolnick, 1995).

One of the limitations of this study is that most of the follow-up weights were self-reported. However, past studies have indicated that self-reports of weight loss are relatively reliable, though slightly understated (e.g., Murphy et al., 1985; Stunkard & Albaum, 1981). Furthermore, because this study did not evaluate the effectiveness of a weight-loss program, average weight loss was not of interest. Our aim was to predict individuals' weight loss from motivational variables, so even if the self-reported weights were understated that is not likely to have affected our results, which were derived from correlational and multiple regression procedures.

In conclusion, the results indicate that patients' autonomous motivation to participate in a weight-loss program is positively related to their staying in the program, losing weight during the program and, perhaps most important, maintaining their lowered weights. The study therefore suggests that self-determination theory, which differentiates between autonomous and controlled forms of motivation, is useful for predicting continued participation in health-promoting treatments and the maintenance of health-relevant behavior change. That seems important and useful, because many past studies have highlighted the difficulty of facilitating both program participation and maintenance of health-promoting behavior change.

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