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Geoffrey C. Williams
Department of Clinical and Social Sciences in Psychology, University of Rochester, Rochester, New York, USA
Marylène Gagné
Department of Management, John Molson School of Business, Concordia University, Montreal, Canada
Alvin I. Mushlin
Weill Medical College, Cornell University, New York, New York, USA
Edward L. Deci
Department of Clinical and Social Sciences in Psychology, University of Rochester, Rochester, New York, USA

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Geoffrey C. Williams
Department of Clinical and Social Sciences in Psychology, University of Rochester, Rochester, New York, USA

Marylène Gagné
Department of Management, John Molson School of Business, Concordia University, Montreal, Canada

Alvin I. Mushlin
Weill Medical College, Cornell University, New York, New York, USA, and

Edward L. Deci
Department of Clinical and Social Sciences in Psychology, University of Rochester, Rochester, New York, USA

Abstract

Purpose – To assess the effect of diagnostic testing for coronary artery disease (CAD) on motivation for change, and on lifestyle change for patients with chest pain.

Design/methodology/approach – This observational study followed patients with chest pain suggestive of CAD for three years. Constructs of autonomous and controlled motivation for lifestyle change, autonomous orientation, and autonomy support from self-determination theory were assessed. Self-reported tobacco use, physical activity, and diet were assessed at baseline and three years later. Physician rating of pre- and post-test probability of CAD were also assessed. CAD diagnosis was established after three years.

Findings – Physicians' autonomy-supportive style and patients' autonomous orientations both predicted greater patient autonomous motivation, which in turn predicted improved diet, more exercise, and marginally less smoking. High probability of CAD also led patients to become more autonomously motivated for lifestyle change.

Research limitations/implications – The observational nature of the study and the self-report measures of health behaviors preclude causal conclusions from this study. Findings from this study suggest that patient motivation and risk behavior are affected by results of cardiac testing, by physicians' support of autonomy, and by patients' personalities.

Practical implications – Physicians may be effective in motivating behavior change around time of testing for CAD.

Originality/value – The self-determination theory model for health behavior change accounted for change in patient health risk behavior change around the time of testing for CAD. Physicians and researchers might use these results to design and test interventions for practitioners to effectively motivate behavior change around the time of medical tests.

Keywords Heart, Diseases, Lifestyles, Motivation (psychology)

Paper type Research paper

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Introduction

The risks of coronary artery disease

Coronary artery disease (CAD) accounts for approximately one-third of the more than 2 million American deaths annually (Thom *et al.*, 1998). Tobacco use, poor diet, and inactivity have been unequivocally linked to CAD as well as to other diseases such as cancer and chronic obstructive pulmonary disease, suggesting that a substantial amount of morbidity and mortality is attributable to their own behavior (McGinnis and Foege, 1993; Mokdad *et al.*, 2004). Further, smoking and unhealthy cholesterol patterns act synergistically to cause CAD (Centers for Disease Control and Prevention, 1990; Stampfer *et al.*, 2000), and physical inactivity not only contributes to CAD (Berlin and Colditz, 1990) but also predisposes people to obesity, hypertension, and diabetes, which are further causes of CAD (Blair *et al.*, 1989; Food and Nutrition Board and Institute of Medicine of the National Academy of Sciences, 2002; Kujala *et al.*, 1998; Wei *et al.*, 1999).

Definitive evidence also indicates that there are substantial reductions in morbidity and mortality attributed to CAD when patients quit smoking, lower their LDL cholesterol, and exercise regularly. For example, by the end of the first year following smoking cessation, patients' risk of developing CAD is reduced by 50 percent (Centers for Disease Control and Prevention, 1990; Benowitz, 2003). Change in these CAD-related behavior patterns is clearly difficult, and relatively little is known about the naturally occurring motivational processes that underlie health-behavior change among patients at risk for CAD. Therefore, the present longitudinal study examined the motivation for behavior change among patients who reported chest pain. Because patients who have an episode of chest pain experience uncertainty, anxiety, and a heightened awareness of their cardiovascular risk, we believed it would be informative to focus on their motivation and behavior as they go through the period of diagnostic evaluation and either do or do not make a long-term behavioral accommodation. A further issue concerns the effects on patients' motivation for lifestyle change when told, after the diagnostic evaluation, that they have a high (versus low) probability of CAD.

Self-determination theory

We used motivational concepts from self-determination theory (SDT) to examine those issues in this three-year study (Deci and Ryan, 1985a). SDT distinguishes between *autonomous motivation*, which refers to feeling a sense of volition, self-initiation, and personal endorsement of a behavior, and *controlled motivation*, which concerns people feeling pressured to do the behavior by some interpersonal or intrapsychic force. For example, a man exercising regularly would be autonomous if he did it because he was personally committed to improving his health and believed exercising would help him reach and maintain that outcome, whereas his exercising would be controlled if he did it because his health care practitioner or a significant other pressured him to do so.

The practical importance of this distinction is that SDT proposes that only autonomous motivation will result in the long-term persistence of behavior change, and it is the maintenance of healthy behavior that leads to reduction in health risk. Previous research has demonstrated that patients' autonomous motivation predicts:

- maintained weight loss among morbidly obese patients in a very low calorie diet program (Williams *et al.*, 1996);
- long-term medication adherence among adult outpatients (Williams *et al.*, 1998b);
- maintained glucose control among patients with diabetes (Williams *et al.*, 1998a, 2004); and
- continuous smoking cessation over 30 months among patients who were advised by a physician to quit smoking (Williams *et al.*, 2002).

SDT further proposes that when important others (e.g. health care practitioners) relate to patients in an autonomy-supportive versus a controlling way, patients are likely to become more autonomously motivated with respect to the target behavior(s). Being autonomy supportive involves the practitioner understanding the patients' perspective, acknowledging their feelings, offering choices in assessment and treatment where reasonable, providing relevant information, and minimizing pressure. In contrast, being controlling involves pressuring or coercing patients to behave in the prescribed ways. We hypothesized that patients will develop and maintain more autonomous motivation when they perceive their physicians to be more autonomy-supportive (Deci *et al.*, 1994).

Research has demonstrated that when patients perceived their doctors as more autonomy supportive, the patients reported greater autonomous motivation for taking their medications and were more adherent (Williams *et al.*, 1998b). Further, the perceived autonomy supportiveness of health care providers predicted:

- improvement over one year in the HbA1c of patients with diabetes (Williams *et al.*, 1998a, 2004);
- autonomous motivation for weight loss and the actual 23-month maintenance of weight loss (Williams *et al.*, 1996); and
- continuous abstinence from tobacco over a 30-month period (Williams *et al.*, 2002).

In sum, previous research has found associations between the autonomy supportiveness of health care practitioners and their patients' autonomous motivation, behavior change, and health outcomes.

In a recent trial of smokers treated with an SDT-based intervention, the intervention was perceived to be more autonomy supportive, and the smokers in this trial perceived an increase in autonomy and competence motivations. In turn, greater motivation resulted in more patients taking medications, and maintaining abstinence for six months compared to those randomized to community care (Williams *et al.*, 2005). Thus, autonomy and competence motivations have consistently predicted change and maintenance of these risk behaviors, and health care environments designed to increase perceived autonomy support have resulted in greater motivation and improved health.

Finally, SDT proposes that individual differences in patients' general motivational orientations will predispose them to become more autonomously motivated for particular behaviors such as diet improvement or increased physical activity when they are in a situation where those behaviors are emphasized (e.g. when they have chest pain suggestive of CAD). A concept within SDT, referred to as general causality orientations, concerns the degree to which people are in general autonomously oriented, at a personality (or individual difference) level. Past studies have found that there is a general autonomy orientation related to patients' autonomous motivation for weight loss and, in turn, to actual weight loss (Williams *et al.*, 1996), as well as to medical students' autonomous motivation for learning in a medical interviewing class (Williams and Deci, 1996). Thus, individuals who tend to experience autonomy across situations are more likely to feel autonomously motivated to reach a specific health goal. Even after controlling for this trait-level of autonomy, the autonomy supportiveness of the health care climate has facilitated patients to experience greater autonomy to reach a health-specific goal. In the present study, we hypothesized that the degree to which patients have a general orientation toward autonomy would predict the degree to which they would become more autonomously motivated for lifestyle change in the months following their diagnostic work-up for CAD.

In sum, this study focuses on the autonomous motivation for lifestyle change of patients who had reported chest pains and were undergoing diagnostic testing for CAD. We hypothesized that improvements in autonomous motivation for lifestyle change to be predicted by patients' autonomous causality orientation and by patients' perceptions of the autonomy supportiveness of their primary care physicians. We also examined whether a diagnosis of high probability of CAD at the time of the work-up would be positively related to change in autonomous motivation for behavior change. Finally, we hypothesized that change in autonomous motivation for lifestyle change would predict change in the relevant behaviors over the three years of follow-up.

Methods

Participants

A total of 509 patients who had reported chest pains suggestive of CAD were referred for diagnostic testing by 44 primary care practices in the Rochester, New York, area. Criteria for eligibility in the study were to be at least 40 years of age, have no prior diagnosis of CAD, and be a good candidate for treadmill exercise testing. A total of 456 of the patients met these criteria. Of these, 66 either declined to participate in the study or were unavailable to schedule meetings with the research team. See Figure 1 for the recruitment outline. The total of 119 patients who did not participate did not differ in age (mean = 56.4, SD = 12.6) from the 390 who did participate (mean = 55.2, SD = 9.9). The percentage of non-participants who were female appears to be larger (59.7 percent) than the percentage of participants who were female (52.3 percent), although this difference was not statistically significant. Finally, the physician-rated likelihood of the non-participants having CAD was 44.8 percent prior to testing, which did not differ from the rated likelihood of the participants having CAD (43.4 percent).

The 390 patients who participated in the study underwent a series of diagnostic tests and completed questionnaires. Ages ranged from 40 to 85 (mean = 55), 48 percent were men, 74 percent were Caucasian, 58 percent were employed, and 76 percent were privately insured. Of these patients, 316 returned the questionnaire at three-year follow-up, although because of missing data, only 252 of these questionnaires were usable, as scales had two or more missing responses. These 252 participants are called

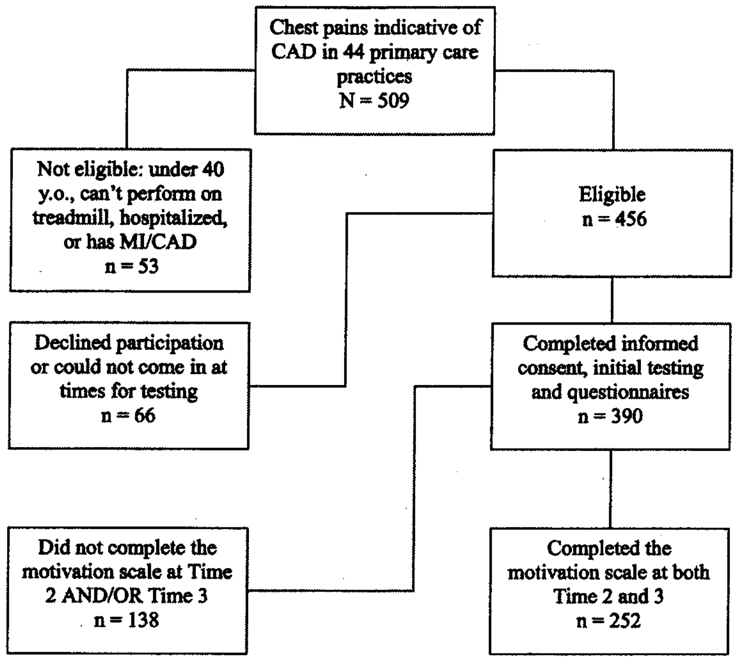

Figure 1.
Recruitment outline

completers and were used for most of the analyses; the remaining 138 are called non-completers.

Procedure

At Time 1 (T1), after providing informed consent, patients completed self-administered questionnaires and were given a series of non-invasive tests for CAD. At Time 2 (T2), about one week after the testing appointment when patients had received test results from their primary care physicians, a post-diagnostic-testing questionnaire was mailed to them. Three years later, at Time 3 (T3), self-administered questionnaires were mailed to the patients and to their physicians. (Figure 2 represents a time-line indicating when each measure was obtained in the course of the study.)

---------------------1 to 2 weeks------------------ // ---------------------------3 years -----

Time 1	**Time 2**	**Time 3**
Tests and record of Risk Behaviors	***Results of Tests***	*Follow up and Final Diagnosis*
Patient	Probability of CAD	***Patient***
Diet	Motivation	Diet
Exercise		Exercise
Smoking		Smoking
Weight		Weight
Probability of CAD		CAD Diagnosis
		Autonomy support
		Motivation

Figure 2.
Time-line indicating when each measure was obtained in the course of the study

Measures

Questionnaire on diet, exercise, and smoking. This measure, given at T1 and T3, asked patients to report on their diets, exercise patterns, and smoking status. Two questions assessed dieting behavior:

(1) "To what extent do you avoid fatty foods?"; and

(2) "To what extent do you attend to maintaining a healthy diet?"

Both questions were answered on a 1 (not at all) to 6 (a great deal) Likert-type scale.

Exercise behavior was assessed with a well-validated scale (Washburn *et al.*, 1987) consisting of three items:

(1) "How active do you consider yourself to be compared to other people your age and sex?", answered on a scale from 1 (much less active) to 5 (much more active);

(2) "Do you engage in regular activities at least once a week?", on a dichotomous (yes/no) scale; and

(3) "How often do you exercise?", on a 1 (not at all) to 8 (seven times a week) Likert-type scale.

Previous research found exercise assessed with this scale to be related to morbidly obese patients' maintenance of weight loss for a period of 23 months (Williams *et al.*, 1996).

One question assessed patients' smoking status using a dichotomous scale coded as 0 (currently not smoking) or 1 (currently smoking).

General causality orientations scale. This well validated scale (Deci and Ryan, 1985b) measures individual differences in general orientations toward being autonomous. Two other orientations – the controlled orientation and the impersonal orientation – were not relevant to this study. Participants read 12 hypothetical scenarios and for each they rate the likelihood of having the reactions that represent the autonomous orientation, using a 1 (very unlikely) to 7 (very likely) scale.

Physician autonomy support. Five items from the Health Care Climate Questionnaire (Williams *et al.*, 1996) were given at T3 to assess the degree to which patients experienced their primary care provider to be autonomy supportive during the three-year period following their work-up. A sample item is "I feel understood by my physician", answered on a 1 (strongly disagree) to 7 (strongly agree) scale. The five items on this questionnaire are presented in the Appendix.

Motivation for lifestyle change. Four items measuring autonomous motivation for lifestyle change were selected from the validated Treatment Self-Regulation Questionnaire (Williams *et al.*, 1996; Ryan and Connell, 1989) and were given at T2 and T3. An example is "I personally believe that such changes will improve my health", answered on a 1 (strongly disagree) to 7 (strongly agree) scale. Three items measuring controlled motivation were also given at T2 and T3. An example is "I would feel guilty if I didn't do what my doctor said". These motivation items are also presented in the Appendix.

Physician rating of probability of CAD. Physicians rated the probability of the patient having CAD based on their clinical evaluations at T1, before diagnostic testing, and at T2, after testing. Physicians tick-marked a 10 cm analog scale anchored by 0 percent (definitely no) and 100 percent (definitely yes) indicating the probability that a patient's symptoms represent CAD.

Diagnosis of CAD. At T3, patients were categorized as either having CAD or not by their physician. This diagnosis was coded as positive (and assigned a value of 1) if the patient had been diagnosed with any CAD-related health problems or undergone any procedures for CAD, including stable angina, unstable angina, myocardial infarction, congestive heart failure, angioplasty, coronary artery bypass surgery, and cardiac transplant surgery. Otherwise, it was coded as negative (and assigned a value of 0).

Weight. Patients' weights in pounds at T1 and T3 were taken from physician records.

Statistical analyses

The two diet items were averaged to form a composite measure at T1 and T3. The diet items at T1 were correlated 0.72, and at T3 they were correlated 0.70. The T1 diet measure was significantly correlated with the patients' weight ($r = -0.22; p < 0.01$), thus providing initial validity for the measure.

The exercise items were combined to form a composite measure by scoring "yes" on the second question as 5 and "no" as 1. Then, each of the three items was z-scored, and the mean of the three z-scores was used as the composite measure for exercise. Cronbach's alpha at T1 was 0.67, and at T3 was 0.66. The correlation of this measure of exercise with patients' weight was $r = -0.24; p < 0.001$.

The autonomous orientation individual difference measure from the General Causality Orientation Scale was calculated by summing the participants' responses (each ranging from 1-7) to 12 vignettes. Thus, the scores range from 7 to 84, and Cronbach's alpha in this sample was 0.74.

The autonomy support score at T3 was calculated by taking the mean of the five items (Cronbach's alpha = 0.89). The motivation for lifestyle change score was represented by the mean of the four autonomous motivation items at T2 (alpha = 0.62) and T3 (alpha = 0.75), and the three controlling motivation items at T2 (alpha = 0.71) and T3 (alpha = 0.73).

The physician-rated probability for coronary artery disease at T1 and T2 were recorded on visual analog scales and represented clinical judgments of how likely the physician felt the patient was to have coronary artery disease. The diagnosis of CAD was a dichotomous "gold-standard" diagnosis that occurred over the three years of the study. The actual diagnosis of CAD at T3 correlated with the physician-rated probability at T2 ($r = 0.59; p < 0.001$).

Analyses of variance and multiple regression were used to assess repeated measurement of variables and to test for interactions of key predictors. A median split was done to dichotomize the probability of CAD at T2 (a continuous variable) to determine if high and low estimates of this variable resulted in different patterns of change in motivation and health behaviors.

Results

Autonomy orientation, response and loss to follow-up

Table I presents differences in the variables measured at the outset of the study between completers ($n = 252$) and non-completers ($n = 138$). Analyses revealed that non-completers scored significantly lower than completers on the autonomy subscale of the GCOS. Non-completers were also marginally younger and had a significantly higher physician-rated likelihood of having CAD. Finally, non-completers exercised less, smoked more, and had a marginally worse diet than did completers. In short, non-completers were less autonomous in their general motivational orientation and were at considerably greater risk for serious health problems than were completers, because the non-completers behaved in less healthy ways. This finding is wholly expectable from a self-determination theory perspective, as those who are less autonomously oriented were also less likely to follow through on their commitment to participate in the study and were less likely to take care of themselves.

Changes in risk behaviors between T1 and T3 and the role of probability of CAD (T2)

All subsequent analyses were performed on completers ($n = 252$). Table II presents the means and standard deviations for the primary variables along with significance tests of change from T1 to T2, from T1 to T3, or from T2 to T3, using *t*-tests for continuous

	Completers	Non-completers	*t*-test	Chi-square test
Age (in years)	55.82 (252)	54.08 (138)	1.71†	
Gender (percent female)	50.0 (252)	57.0 (138)		−1.52
Probability of CAD (percent)	41.70 (245)	46.57 (134)	−2.01*	
GCOS autonomy	5.69 (249)	5.43 (116)	2.57**	
Diet	4.16 (252)	3.87 (130)	1.83†	
Exercise (standardized)	0.04 (252)	−0.13 (131)	2.02*	
Smoking status (percent)	12.0 (252)	30.0 (130)		−4.10***
Weight	181.82 (245)	187.86 (137)	−1.30	

Note: The numbers of patients who provided data for these variables are in parentheses after the means or percentages; †$p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table I. Comparison of completers and non-completers on variables measured at Time 1

Variables	Time 1 (SD)	Time 2 (SD)	Time 3 (SD)	*n*	*t*-test
Diet	4.15 (1.43)		4.67 (1.26)	250	6.35***
Exercise (standardized)	0.04 (0.76)		0.04 (0.76)	250	0.01
Smoking (percentage of smokers)	12.0		10.0	252	−0.83
Weight	182.60 (39.30)		180.07 (39.99)	230	−2.40*
Coronary artery disease (percent)	41.63 (22.98)	31.38 (29.61)	24.1[a]	238	−5.54***
Autonomous motivation		6.07 (0.81)	5.86 (1.02)	252	−3.43***
Controlled motivation		5.30 (1.26)	4.99 (1.42)	252	−3.96***

Note: Coronary artery disease is measured as a physician's rated probability at T1 and T2, and as percentage of patients who had actually had CAD by Time 3. The significance test for this variable compares T1 and T2 to evaluate whether the average rated probability of CAD changed as a function of the diagnostic testing; [a]data from 232 patients; * $p < 0.05$; *** $p < 0.001$

Table II. Means and percentages on outcome variables for completers at all three assessment times, with significance tests variables and z-tests for percentages. Results indicate that patients reported significant improvements in eating healthy diets over the three years of the study and that they lost a small, though statistically significant, amount of weight over the three years. Physician ratings of the probability that the patients had CAD decreased from T1 to T2, which most likely reflected adjustment in probability of CAD based on the diagnostic test results. Finally, patients' autonomous motivation and their controlled motivation for adopting a healthy lifestyle decreased significantly from T2 to T3. The small decreases in motivation over the three years is not unusual, because people who are highly motivated for change when they have experienced chest pains and are undergoing diagnostic testing often find it difficult to maintain that motivation over the long term.

Changes in autonomous motivation and control motivation variables between T2 and T3 and the role of probability of CAD (T2)

Next, we examined whether patients who were told by their physicians at T2 that they were at high risk of having CAD would be more likely to change their health-related motivations and behaviors in the subsequent months than would those told they were at lower risk for CAD. We did a median split on the T2 ratings of probability of CAD and then examined the T2 and T3 self-reports of motivation and behavior of the two groups of patients. Table III presents means or percentages on these variables for patients with high and low T2 probability of CAD. We performed 2×2 repeated measures analyses of variance on these variables to see whether there was a main effect for time, a main effect for diagnostic probability, and an interaction.

First, patients became less autonomously motivated over time ($F = 9.09$; $p < 0.01$); however, there was an interaction between time and probability of CAD ($F = 3.94$; $p < 0.05$) such that those with a high likelihood of CAD maintained their autonomous motivation over the three years, whereas those with a low likelihood lost considerable autonomous motivation. Second, patients also lost controlled motivation for healthy living over the three years ($F = 12.97$; $p < 0.001$), although diagnostic probability had no main or interactive effect. Third, there was significant improvement in diet over the three years ($F = 41.85$; $p < 0.001$), and there was an interaction ($F = 5.91$; $p < 0.02$) such that there was greater improvement in diet for those with a high likelihood of

Variables	Low probability Time 2	Low probability Time 3	High probability Time 2	High probability Time 3
Autonomous motivation	6.03 (122)	5.74 (122)	6.08 (123)	6.01 (123)
Controlled motivation	5.26 (122)	4.89 (122)	5.31 (123)	5.11 (123)
	Time 1	Time 3	Time 1	Time 3
Diet	4.17 (121)	4.50 (121)	4.14 (122)	4.87 (122)
Exercise	0.07 (121)	0.05 (121)	0.03 (122)	0.04 (122)
Smoking status (percent)	11.0 (122)	10.0 (122)	11.0 (123)	9.0 (123)
Weight	182.10 (109)	180.81 (109)	182.15 (114)	178.40 (114)

Notes: The split was made at the median level of probability for CAD on 245 patients (20 percent); the numbers of patients are in parentheses after the means and percentages

Table III. Means and percentages on outcome variables broken down by Time 2 probability of CAD

CAD. Fourth, patients lost a small though significant amount of weight over the period ($F = 5.63$; $p < 0.02$), but this was not influenced by diagnostic probability. No other effects were significant.

Preliminary indication of the relations among variables can be found in the zero-order correlations shown in Tables IV and V. For these correlations, changes in autonomous motivation and in controlled motivation were calculated by subtracting the T2 scores from the T3 scores. Perceived autonomy support, reported at T3 concerning the period of the study, was positively related to change in autonomous motivation from T2 to T3 ($r = 0.28$; $p < 0.001$). Autonomous causality orientation was also correlated with change in autonomous motivation from T2 to T3 ($r = 0.13$; $p < 0.05$). In turn, as is also shown in Table V, change in autonomous motivation related positively with diet at T3 ($r = 0.19$; $p < 0.01$) and with exercise at T3 ($r = 0.15$; $p < 0.05$).

According to SDT, both autonomy support from primary physician and autonomous causality orientation of the patient should predict change in the patient's autonomous motivation, and the correlations indicate that both these relations were significant. To ensure that both contributed independently, we performed a simultaneous regression analysis. In this analysis, and in all subsequent regression analyses, we created an unstandardized residual representing change in autonomous motivation over the three years by regressing T2 autonomous motivation out of T3 autonomous motivation. Thus, for the present analysis, we regressed T3 autonomous motivation onto T2 autonomous motivation and then simultaneously entered both perceived autonomy support and autonomy orientation. Both were significant predictors. The F value for the equation, with 3 and 244 degrees of freedom, was 44.19 ($p < 0.001$). For autonomy support, $\beta = 0.26$ ($p < 0.001$) and for autonomous orientation, $\beta = 0.14$ ($p < 0.001$).

Changes in risk behaviors between T1 and T3 and the effects of CAD (T2) and autonomous motivation and their interaction

Table VI presents partial correlations between the motivation variables (at T2 and T3) and the behavioral outcome variables at T3, controlling for the outcome variables at T1. Autonomy orientation did not directly predict change in any of the behaviors,

Autonomy orientation	1	2	3	4	5	6	7
Autonomy support T3	0.02						
Autonomous motivation T2	0.09	0.14*					
Autonomous motivation T3	0.20**	0.36***	0.49***				
Change in autonomous motivation	0.13*	0.28***	−0.33***	0.66***			
Controlled motivation T2	−0.10	0.11	0.37***	0.09	−0.23***		
Controlled motivation T3	0.00	0.14*	0.30***	0.34***	0.11	0.58***	
Change in controlled motivation	0.10	0.05	−0.03	0.31***	0.36***	−0.35***	0.56***

Note: n varies from 248 to 252; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table IV. Correlations among motivation variables

Table V.
Correlations between motivation variables and health outcomes

	Diet T1	Diet T3	Exercise T1	Exercise T3	Smoke T1	Smoke T3	Weight T1	Weight T3
AO	0.12	0.11	0.02	0.06	−0.13*	−0.11	0.05	0.07
AS T3	0.16**	0.25***	0.10	0.14*	−0.15*	−0.15*	−0.08	−0.12
AM T2	0.33***	0.27***	0.27***	0.15*	−0.10	−0.11	−0.23***	−0.16**
AM T3	0.24***	0.40***	0.25***	0.26***	−0.13*	−0.15*	−0.05	−0.05
CAM	−0.03	0.19**	0.04	0.15*	−0.06	−0.06	0.14*	0.10
CM T2	0.05	0.08	0.08	−0.04	−0.08	0.03	−0.11	−0.14*
CM T3	0.06	0.18**	0.19**	0.01	−0.12	−0.06	−0.14*	−0.13*
CCM	0.02	0.12	0.14*	0.05	−0.05	−0.09	−0.05	−0.01

Note: n varies from 234 to 252; AO = autonomy orientation; AS = autonomy support; AM = autonomous motivation; CAM = change in autonomous motivation; CM = controlled motivation; CCM = change in controlled motivation; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table VI. Partial correlations between predictor and outcome variables, controlling for the outcome variable at Time 1

	Diet T3 (243)	Exercise T3 (243)	Smoke T3 (245)	Weight T3 (223)
Autonomy orientation	0.05	0.06	−0.01	0.11
Autonomy support T3	0.20**	0.12	−0.09	−0.13
Autonomous motivation T2	0.12	0.02	−0.06	0.02
Autonomous motivation T3	0.33***	0.16**	−0.11	−0.07
Autonomous motivation residual	0.30***	0.16**	−0.05	−0.06
Control motivation T2	0.07	−0.09	0.14*	−0.12
Control motivation T3	0.17**	−0.10	0.03	−0.08
Control motivation residual	0.16**	−0.06	−0.04	0.01

Note: The number of patients for each behavioral outcome is in parentheses after the behavior. Change in autonomous motivation and change in controlled motivation were indexed with unstandarized residuals formed by regressing T3 scores onto T2 scores for that variable; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

although autonomy support did predict significant change in diet. Further, change in autonomous motivation (indexed as an unstandardized residual), which was theorized to be the proximal predictor of change in the risk behaviors, was significantly related to change in both diet and exercise. Finally, change in controlled motivation (also indexed as a residual) was also positively related to change in diet.

Direct and interaction effects of change in autonomous motivation and high versus low diagnostic probability on change in health behaviors were tested using regression analyses. For these analyses, as for the ones reported in the previous paragraph, change in health behaviors and change in autonomous motivation were both created with regression procedures. Specifically, for each behavior, the T3 behavior was regressed onto T1 behavior to create the change residual, and then diagnostic probability and residualized change in autonomous motivation were entered, followed by their interaction. Our primary hypothesis was that change in autonomous motivation would predict change in health-risk behaviors. The interaction term was used to examine whether change in autonomous motivation would have a differential effect on behavior change for people with high versus low probabilities of having CAD. Table VII presents the results of these analyses. The first row for each behavior reports the tests for main effects of diagnostic probability and change in autonomous motivation. The second row reports tests for the interaction, showing what happens to the main effects when the interaction is included.

Results indicate that a high probability of CAD and change in autonomous motivation both led to significant improvement in diet over the three-year period. When the interaction was entered, the interaction effect was found to be significant, indicating that the positive effect of change in autonomous motivation on diet improvement was primarily for people with a high probability of CAD. Further, the results of the regressions showed a main effect for change in autonomous motivation on exercise over the three years, and a marginally significant positive effect of change in autonomous motivation on smoking. The interaction of diagnostic probability and change in autonomous motivation did not affect change of exercise or smoking and the main effects did not change when the interaction was entered. Finally, although there

	Step 1 Dependent variable T1	Diagnosis T2	Step 2 Residualized autonomous motivation	Step 3 Diagnosis × motivation	*F*-test
Diet T3	0.51***	0.12*	0.24***		44.65***
	0.50***	0.10†	0.13†	0.16*	35.38***
Exercise T3	0.50***	−0.07	0.18**		34.43***
	0.50***	−0.06	0.18*	−0.01	25.72***
Smoking T3	0.75***	−0.03	−0.07†		107.58***
	0.74***	−0.02	−0.02	−0.07	81.15***
Weight T3	0.92***	−0.02	−0.04		386.23***
	0.92***	−0.02	−0.05	0.01	288.55***

Table VII. Standardized results of the regression analyses

Note: Residualized autonomous motivation is unstandardized, created from a regression analysis where Time 3 autonomous motivation was regressed on to Time 2 autonomous motivation; †$p < 0.10$; * $p < 0.05$; ** $p < 0.01$, *** $p < 0.001$

was a small though significant reduction in weight over the three years, neither diagnostic probability nor change in autonomous motivation predicted this change.

According to SDT, improvements in these difficult-to-change risk behaviors are most likely to occur as a function of health care providers being autonomy-supportive, which should lead to enhancement in autonomous motivation and in turn to behavior change. This prediction represents a mediational hypothesis. Because both autonomy support and change in autonomous motivation predicted diet improvement, and because autonomy support and change in autonomous motivation were related to each other, we tested the mediational hypothesis for diet improvement. In the regression, T3 diet was regressed onto T1 diet to create the change residual. Then, perceived autonomy support was entered and found to be significant ($\beta = 0.17$, $p < 0.001$). Finally, the residual representing change in autonomous motivation was entered and was found to be significant ($\beta = 0.22$, $p < 0.001$). Further, when change in autonomous motivation was entered, the significant relation of autonomy support to diet improvement dropped to a marginal level ($\beta = 0.10$, $p < 0.10$). This is consistent with the hypothesized mediation by change in autonomous motivation of the relation from autonomy support to diet improvement.

Discussion

The current study examined the relevance of self-determination theory for predicting long-term change of health-risk behaviors in patients were undergoing diagnostic testing for CAD. Results confirmed that change in autonomous motivation over the three-year period was significantly positively related to diet improvement and exercise, and was marginally related to smoking cessation, over the same period. Thus, change in autonomous motivation for a healthy lifestyle was a predictor of these difficult-to-change health-risk behaviors. It is worth noting that in this study, the measure of autonomous motivation concerned the general goal of living a healthy lifestyle, whereas in previous studies the measure has focused on specific health behaviors such as smoking cessation. This may provide an explanation for why a previous study of continuous smoking cessation over 30 months (Williams *et al.*, 2002) reported stronger relations between autonomous motivation and smoking cessation than did the current study.

Further, diagnostic probability of CAD affected motivation and behavior-change variables. First, in general, patients became less autonomously motivated over the three years following their chest pain incident and diagnostic testing. However, those patients whose test results indicated that their probability of CAD was higher were able to maintain the relatively high level of autonomous motivation for healthier living that they reported at the time of the work up. In other words, receiving results indicating a higher likelihood of CAD led patients to maintain autonomous motivation for lifestyle improvement. Second, with respect to the improvement in diet over the three years, diagnostic probability contributed as a main effect, indicating that those with a higher probability of CAD were more likely to improve their diet. This finding is consistent with previous research showing greater reduction in risk behaviors following a coronary event (Dornelas *et al.*, 2000). Third, diagnostic probability and change in autonomous motivation interacted with respect to diet improvement, indicating that the diet improvement attributable to change in autonomous motivation occurred primarily for patients with a high probability of CAD.

A second hypothesis was that patients' autonomous orientation (or personality) and their perceptions of their primary care providers being autonomy-supportive would contribute positively to change in autonomous motivation over time. This was supported, as both variables contributed significant independent variance to change in autonomous motivation. The positive effect of autonomy support is a particularly important finding because it indicates that when primary care physicians are able to take the patient's perspective, hear and convey an understanding of what they are saying, and offer choice of treatment where possible, their patients are likely to be more autonomously motivated to live in a healthier way. In fact, we did this analysis separately for patients with high and low probability of CAD and perceived autonomy supportiveness of the physician positively predicted a change in autonomous motivation for both groups. Furthermore, with respect to diet, perceived autonomy support had a direct effect on reported improvements over the three-year period, and as hypothesized by self-determination theory, this relation was mediated by change in autonomous motivation.

The clinical and health services implications of these findings are first, that one of the important roles of diagnostic testing may be for physicians to utilize the contact time around diagnostic testing with patients to motivate lifestyle change, because those patients who received indication of a high likelihood of CAD were more able to maintain motivation and improve health behaviors. Chest pain patients with low probability of CAD, in contrast, lost a significant amount of their motivation for change. Nonetheless, the results also showed that those with a low probability of CAD were more able to maintain their motivation for change if their physicians were autonomy supportive. It is well known that lifestyle improvement is extremely difficult to promote and that the health care implications are monumental (Orleans, 2004). More than a third of all American deaths each year are attributable to poor diet, lack of exercise, and smoking (McGinnis and Foege, 1993; Mokdad *et al.*, 2004; Woolf, 1999). The current study is consistent with the view that it is important for physicians to be both autonomy supportive and to provide clear diagnostic information as suggested by the National Cholesterol Education Program (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001; Grundy *et al.*, 2004), although further research is necessary to gain a more exacting indication of the health services consequences (i.e. the cost effectiveness) of pairing health behavior counseling with diagnostic tests to motivate health-related behavior.

Clinical interventions that are likely to increase autonomous motivation are ones that fully inform patients of their health risks and the potential health benefits from lifestyle change and medical treatments. In order for people to initiate change and then sustain it means that they have to be able to integrate their motivation for health with their values related to other life domains (e.g. work and family). Thus, research might examine whether patients perceive greater autonomy support (i.e. become more fully informed) when they are provided with an accurate assessment of their current cardiovascular risk, and the expected benefits of lifestyle change and medications compared to what typically happens in primary care. Another clinical intervention might focus on determining the specific components of the intervention that is most effective in increasing patient autonomous motivation and behavior change, and in maintaining it over time.

Analysis of participants who failed to complete the study versus those who did complete it is interesting in terms of research on the change of smoking, diet, and exercise behaviors. Studies of health behavior change routinely lose a large percentage of participants, and the present study suggests that dropouts tend to be less autonomously motivated and to engage in more risk behaviors. This has two important implications. First, the phenomenon restricts the range of the autonomy variables, making it more difficult to obtain statistically significant relations to health outcomes. Second, less motivated individuals may not only drop out more but may also be less likely to enter programs and studies, in which case the success rates reported by many programs may represent overestimates of what the success rates would be if the less autonomously motivated individuals participated in the programs and studies.

Limitations of this study include that its observational nature and the self-report measures of health behaviors preclude making conclusions about autonomous motivation causing health-related improvements in diet, exercise, and smoking. Also, the relatively high rate at which smokers dropped out of the study and the small number of participants, render the smoking analyses only suggestive.

Together, the findings from this study with the results of previous studies relating autonomous motivation to other important health outcomes support the self-determination model for behavior change. This model suggests that autonomy supportive providers tend to facilitate patients' greater autonomous motivation for a healthy lifestyle, which in turn leads to positive health behavior change. Further research is called for to develop interventions that facilitate people's autonomous motivation for healthier living when they are being presented diagnostic information as well as when they are simply being counseled about their lifestyle.

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Appendix

Items from the treatment self-regulation questionnaire (TSRQ) and the health-care climate questionnaire (HCCQ)

The response range for both scales is from 1 (strongly disagree) to 7 (strongly agree).

Autonomous motivation for change (TSRQ)

I would make the recommended changes in my lifestyle (e.g. exercise more, reduce fats and salt in my diet, stop smoking, and reduce stress) because:

- I find it a personal challenge to get as healthy as I can.
- I personally believe that such changes will improve my health.
- I feel changing my lifestyle is a good way to improve my health.
- It's exciting to try to make myself healthier.