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Exercise-Specific Volition and Motivation for Weight Loss Maintenance Following an Intensive Lifestyle Intervention

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Objective: The present study investigated the influence of exercise-specific motivation and volition on weight loss maintenance following an intensive lifestyle intervention (ILI). ***Method:*** The study participants were 164 individuals with obesity (body mass index [BMI] $>$ 30 kg/m^2) that participated in an ILI. Participants' exercise-specific volition and motivation were assessed before and after the intervention as well as 3 and 12 months after completion. Volition was measured with the Volition in Exercise Questionnaire and motivation was measured with the context translated Sport Motivation Scale. ***Results:*** Mixed model analysis revealed that when adjusting for gender, age, and education, the 6 volitional scales and intrinsic motivation predicted BMI across the 4 time points, whereas 6 volitional scales and 2 extrinsic regulation scales showed a time interaction. Backward elimination multiple mixed model analysis revealed that Volitional Inhibition - Postponing Training and Volitional Facilitation - Self-Confidence predicted BMI development, whereas Volitional Inhibition - Unrelated Thoughts, Identified Regulation, and Introjected Regulation showed a time interaction above and beyond the other scales. ***Conclusion:*** Exercise-specific volition and motivation influence weight loss maintenance following an ILI. Volitional self-confidence and the tendency to postpone training are of importance above and beyond the previously identified predictor of autonomous exercise motivation. Results of the study also indicate that extrinsic motivation can be either facilitating or counterproductive depending on the level of self-determination.

Keywords: self-regulation, incentives, obesity, physical activity

Obesity is considered to be one of the leading health concerns in the world (World Health Organization, 2013). Consequently, both in the scientific community as well as in society in general, a great number of resources have been devoted to developing noninvasive methods for helping individuals battling with obesity obtain and maintain weight loss. Noninvasive interventions assist individuals with obesity in obtaining and maintaining weight loss through changes, for example, in their diet and exercise behavior. However, the success rates of such programs are, at best, moderate, and in the long term, very few individuals actually succeed in overcoming obesity (Christiansen, Bruun, Madsen, & Richelsen, 2007).

Recent literature suggests that the task of weight maintenance is so difficult because the body prefers regain over maintenance (Ochner, Barrios, Lee, & Pi-Sunyer, 2013). Evidence suggests that factors such as gender (Rolls, Fedoroff, & Guthrie, 1991), age (McTigue, Hess, & Ziouras, 2006), and societal status determined by income and education (Drewnowski, 2009) are of importance to both the prevalence of obesity and the effectiveness of interventions. However, it has recently been suggested by Dandanell, Ritz, Verdich, Dela, and Helge (2017) that repeated participation in weight loss programs could be a solution to obtaining long-term weight loss. The investigated weight loss program in the Dandanell et al. publication combined calorie restriction, several hours of daily physical activity, and behavioral counseling in a community setting in which the participants were away from their daily life and were together with like-minded people who shared the goal of losing weight. Studies investigating the psychological factors underlying the success of such interventions, hereafter referred to as *intensive lifestyle interventions* (ILIs), however, are lacking. Research has shown that for weight loss maintenance, regular participation in exercise activities is especially important when compared with other relevant activities, such as eating behavior (Teixeira et al., 2015). However, adherence to such activities has also proven to be a difficult task for individuals battling obesity (Colley et al., 2008).

Successful exercise adherence for individuals with obesity has been associated with motivational and self-regulatory factors

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(Silva et al., 2011). Promising results have shown that self-regulation skills impact weight control in studies on short-term (<12 months) weight control (Teixeira et al., 2015); however, these self-regulation skills often refer merely to discrete behaviors (e.g., self-weighing) and are rarely based on sound theory. The underlying psychological mechanisms behind self-regulation skills are not well described. Research on the underlying psychological factors of a successful intervention has focused mainly on the motivational constructs of Deci and Ryan's (2000) self-determination theory and self-efficacy based on Bandura's (1989) social cognitive theory (Teixeira et al., 2015). Although motivational constructs provide knowledge about why certain goals are chosen over others, they do not provide knowledge about the self-regulatory mental processes that underlie concrete planning and carrying out of needed actions in order to achieve the goal. Such mental processes are described by the construct *volition*, for example, in the personal system interaction theory (Kuhl, 2000). Motivational psychologists following this theory have argued for a clear distinction between motivation and volition, and an inclusion of both constructs when explaining human behavior (Gollwitzer & Oettingen, 2012; Heckhausen, 1991; Kuhl, 1992). This distinction between the motivational and volitional phases of goal-directed human behavior is described in the Rubicon model of action phases. In this model, two phases are labeled as *motivational* and two are labeled as *volitional* in nature. The first phase, the predecisional phase—in which the goal is formulated and positive consequences of achieving the goal are considered—requires a motivational mind-set. The second phase, the preactional phase, is when the concrete steps of reaching the goal are planned and a volitional mind-set is required. The third phase, the actional phase, is when the individual engages in the actual action required to reach the goal. This phase also requires a volitional mind-set. Finally, in the fourth phase, the postactional phase, the goal pursuit and the related consequences are evaluated, and in this phase, the individual has a motivational mind-set (Heckhausen, 1991). One important conclusion of a large systematic review examining the importance of psychological factors' for weight loss maintenance was that a combination of implementation factors and motivation was found to be important, and that "there is some indication that the latter may be especially useful in early stages of behavioral adoption, whereas motivational factors may be operative along the entire continuum from adoption to maintenance, as highlighted recently in a separate study." (Teixeira et al., 2015, p. 25). This conclusion is in accordance with the argument of combining volition and motivation when explaining behavior as suggested by the Rubicon model of action phases (Heckhausen, 1991).

Research on the importance of volition in the area of exercise psychology is very limited; however, volitional skills have proven to be a sound predictor of performance in other areas of sport such as elite sports (Elbe, Szymanski, & Beckmann, 2005; Wenhold, Elbe, & Beckmann, 2009). Research on the underlying mechanisms behind exercise-specific self-regulation factors has focused mainly on the motivational phases of the Rubicon model of action phases. Thus far, no studies have simultaneously looked at the psychological constructs involved in all four action phases. This is in contrast to what is suggested in recent literature and presents a research gap. Recent literature suggests that in order to understand how the psychological constructs of exercise-specific motivation and volition influence the weight maintenance process, it is not sufficient to investigate them in isolation. In order to fully understand their effect, one must control for the effect of the other constructs (Slovinec D'Angelo, Pelletier, Reid, & Huta, 2014).

As described above, Teixeira and colleagues (2015) suggested that motivational and volitional factors might operate differently in the diverse phases from adaptation to maintenance. It was therefore a priori hypothesized that the effect of exercise-specific motivational and volitional factors on weight loss maintenance and exercise adherence would be significantly different in the adaptation phase compared with the maintenance phase. Furthermore, it was a priori hypothesized that their effect would become larger as distance from baseline increased. To investigate this hypothesis, the psychological predictors' interactions with time should be investigated (Heckhausen, 1991; Teixeira et al., 2015). So the purpose of the present study was therefore to include the psychological variables relevant for all four action phases and to investigate whether exercise-specific motivation and volition predict exercise activity levels and weight loss maintenance success after an ILI.

Method

Participants and Procedure

Ethical approval was obtained from the local Research Ethics Committee in Copenhagen, Denmark (No. H-3–2013-146). The study design was reported to clinicaltrials.gov (NCT01997034, NCT01997060). Informed consent was obtained from all participants.

This study focused on participants at an ILI at Ubberup Folk High School in Denmark. Ubberup Folk High school has been offering specialized courses in lifestyle changes since 2000. Ubberup offers four courses each year and approximately 80 individuals participate each time. The participants live at the folk high school for 14 weeks. During this time, they need to take time off from their regular jobs, which can result in loss of salary, and have to pay around €3,000 (3,500 $) in fees to the school. At the beginning of the stay, a team of professional staff, comprised of physiologists, physiotherapists, psychological coaches, and teachers, tailors a physical activity schedule and a diet plan according to the individual participant's specific physical and psychological requirements/characteristics. The individual goals of the participants are adjusted weekly in collaboration with the staff at the school. On a regular day, exercise classes, cooking classes, and theoretical classes on different subjects relevant for successfully adopting a lifestyle change are held between 7:00 a.m. and 4:00 p.m. In addition, the participants choose classes that are not related to their lifestyle change; examples of these classes include singing, art, religion, politics, debate, and philosophy. Physiologists and physiotherapists supervise the exercise classes, and cooks and dieticians teach practical cooking lessons. The participants are offered psychological coaching from a certified coach during their stay. In the coaching sessions, different areas in line with the individual's needs are addressed; however, one area that is covered for most participants is ensuring that the lifestyle change obtained at Ubberup Folk High School is sustainable and continues beyond the intervention. Dandanell (2016), using both accelerometer and dietary measures, showed that the participants at Ubberup are physically active between 1 and 3 hr each day at a moderate to low

intensity and that they have an average energy deficit of 500 to 700 kcal/day. Dandanell and colleagues (2017) provides a thorough description of the content of the ILI.

Data were collected before and after the 14-week-long ILI (Time 1 [T1]) and Time 2 ([T2]) as well as at two follow-up measurement points 3 months (Time 3 [T3]) and 12 months (Time 4 [T4]) after the ILI ended. Data at T1 and T2 were collected via paper and pencil directly at Ubberup, whereas data at T3 and T4 were collected via an electronic questionnaire that was distributed via e-mail. Participants from three consecutive courses were recruited. Only participants with obesity (body mass index [BMI] $\geq$ 30 kg/m^2) at the beginning of the ILI were included in the study. These 164 participants were aged 33.0 (SD = 15.0) years on average, and 67.1% of them were female. With regard to the highest completed level of education, 39.6% reported high school or less, 30.5% short secondary education, and 20.1% had completed a university education (9.8% did not report). All participants were informed in writing before and gave their consent to participate before in writing before the study began.

Measures

Volition. Exercise-specific volition was measured with the Volition in Exercise Questionnaire (VEQ; Elsborg, Wikman, Nielsen, Tolver, & Elbe, 2017). The VEQ measures six aspects of volition with a total of 18 items. The six different aspects are divided into four volitional inhibition (VI) factors that hinder an individual's goal attainment and two volitional facilitation (VF) factors that facilitate goal attainment. VI Focus on Reason for Training (two items; e.g., "During my exercise activity I often focus on my reason for participating") refers to the extent to which an individual deliberates on the reasons for participating in the activity. VI Postponing Training (four items; e.g., "I often experience that I really need to pull myself together to participate in my exercise activity") refers to the extent to which the individual lacks energy to engage actively in the activity, that is, the tendency to procrastinate in relation with the activity. VI Unrelated Thoughts (three items; e.g., "During my exercise activity I find it difficult to concentrate because my thoughts drift to other things than the activity itself") refers to the extent to which the individual can concentrate by shutting out unwanted thoughts and emotions. VI Focus on Approval From Others (three items; e.g., "I feel I have to meet others' expectations during my exercise activity") refers to what extent the individual is susceptible to other people's opinions in conjunction with exercising. VF Self-Confidence (three items; e.g., "I am convinced that I am able to carry out strenuous exercise activities") refers to what extent the individual feels that he or she can succeed in the exercise context. And finally, VF Coping With Failure (three items; e.g., "When I make a mistake during my exercise activity I quickly move on") entails to what extent the individual can cope with and learn from an experience of failure. The questionnaire applies a Likert-scale answering format from 0 = *does not correspond at all* to 3 = *corresponds exactly*.

Motivation. A Danish version of the Sport Motivation Scale (Pelletier et al., 1995) was used to measure motivation concerning exercise. The SMS measures three different aspects of motivation with a total of 28 items. Intrinsic Motivation (12 items; e.g., "For the pleasure of discovering new training techniques") measures the extent to which an individual is motivated to participate in exercise by the activity itself and not by external rewards. Extrinsic Motivation (EM) assesses whether an individual is motivated to participate in exercise for obtaining positive or avoiding negative consequences. EM is divided in three different types: EM Identified Regulation (four items; e.g., "Because it is one of the best ways to develop new aspects of myself."), EM Introjected Regulation (four items; e.g., "Because I must exercise to feel good about myself"), EM External Regulation (four items; "Because people around me believe that it is important to be in shape."). Finally, the third type of motivation is Amotivation (four items, e.g., "It is not clear to me anymore. I don't think I belong in exercise"), which refers to the extent to which the individual lacks motivation to participate in exercise. The questionnaire applies a Likert-scale answering format from 0 = *does not correspond at all* to 6 = *corresponds exactly*. Each item answers the question "What appeals to you in exercise?" The Danish version of the SMS was developed prior to this study and adjusted from the elite context to the exercise context using the translation and back-translation method.

Weight loss maintenance. In order to investigate motivation and volition's influence on weight loss maintenance, participants' weight and height were measured before and after the ILI by Ubberup's nutritionist. At the 3- and 12-month follow-ups, the participants self-reported their weight. The participants' BMIs were calculated at each time point based on these measurements. Successful weight loss maintenance has been described as "losing at least 10% of initial body weight and keeping it off for at least 1 year" (Wing & Hill, 2001, p. 323). However, in the analytic approach of this study, weight loss maintenance was determined by the development of BMI, which was used as a continuous variable at all four time points.

Demographic information. Age, gender, and education level were assessed in a biographical section of the questionnaire. Education level was assessed with the question "What is the highest level education you have completed?" For each category, examples of common education programs in Denmark were given. If uncertain, the participant had the opportunity to ask the questionnaire administrator (the first author of this article).

Exercise participation. Exercise participation was measured with the same self-report question both before and at the 12-month follow-up. This measure has not previously been validated. *Exercise participation* was defined as organized activities with a physical aspect in which participants had to get dressed to participate. Based on this definition, participants were asked to report their weekly activity in exercise by answering the following question: "How often do you participate in exercise?" The participants were given the following eight response options: 1 = *never*, 2 = *less than once a month*, 3 = *1–2 times a month*, 4 = *1 time a week*, 5 = *2 times a week*, 6 = *3 times a week*, 7 = *4 times a week*, and 8 = *5 times a week or more*. These responses were then coded to weekly participation. The first author was present at the first data collection, which meant that the participants could ask for examples of activities and if a certain activity could be regarded as exercise, if they did not understand the provided definition.

Statistical Analysis

This was the first study investigating the predictive power of exercise-specific volition and exercise-specific motivation in combination; therefore, an exploratory approach was undertaken. To investigate the effects of the psychological predictors (motivation and volition) on BMI and possible interactions (Predictor × Time), linear mixed models was performed. The Predictor × Time interaction was included in the model to investigate whether the predictors have different effects on the dependent variable at different timepoints. In order to investigate the joint predictive power of the volitional and motivational factors, and given the exploratory nature of this study, a multiple stepwise mixed model was conducted. Only the significant predictors were included in the stepwise regression. Mixed models as a statistical method was chosen both because it can include all variables at all four time points and because it can deal with missing data. This was done with the assumption that outcomes changed linearly over time during the intervention and in between follow-up time points. Variance components were used as covariance structure. Subject differences were modeled as random effects. Statistical analyses were conducted using SPSS 23.

Results

Study Variable Summary

Of the 164 participants that were included in the study, 103 completed the psychological questionnaires at T2, 98 at T3, and 74 at T4. Some participants had missing answers in the questionnaires, which meant that the valid *N* of each variable, even at the same time point, differed. Descriptive statistics of the study variables are presented in Table 1.

As shown in Table 2, and as expected, several of the psychological predictors were significantly correlated. In order to ensure that multicollinearity was not an issue a variance inflation factor (VIF) was calculated for the psychological predictors at baseline. The VIF values for the predictors were between 1 and 10 (range = 1.36–2.36), which means that it can be concluded that there were no multicollinearity issues (Kutner, Nachtsheim, & Neter, 2004).

Reliability

Scale reliabilities for the scales of VEQ and SMS were analyzed with Cronbach's alpha. A value of .70 was regarded as an acceptable value (Streiner, 2003). Values are presented in Table 1. All SMS scales showed good reliability. The VEQ scales also showed good reliability, with the exception of the two scales VI Approval From Others (T1, $\alpha = .67$; T2, $\alpha = .67$; T4, $\alpha = .66$) and VI Reasons (T2, $\alpha = .68$; T4, $\alpha = .69$), which were slightly under the threshold.

Separate Mixed Model Analysis

In every model gender, age, and education status were controlled for. Models with participation in exercise as the outcome confirmed it as a strong predictor of BMI. All psychological scales predicted exercise participation in the expected directions with the exception of VI Approval From Others (see Table 3).

Table 1
Summary of the Characteristics of the Study Variables at Baseline, 14-Week Postintervention, 3-Month Follow-Up, and 12-Month Follow-Up

Variable	Unit/ Range	Baseline				14-week postintervention				3-month follow-up				12-month follow-up			
		M	*SD*	*N*	α	*M*	*SD*	*N*	α	*M*	*SD*	*N*	α	*M*	*SD*	*N*	α
Outcome variables																	
BMI	kg/m^2	39.62	7.69	164	—	35.91	7.15	157	—	34.78	6.31	86	—	35.77	6.25	74	—
Exercise participation	times/wk	1.13	1.33	153	—		Not measured				Not measured			2.36	1.81	75	—
Psychological variables																	
VF Coping With Failure	0–3	1.81	.79	149	.81	1.92	.67	101	.74	1.98	.69	97	.81	1.90	.76	73	.87
VI Approval From Others	0–3	1.47	.83	149	.67	1.39	.82	102	.67	1.38	.85	97	.71	1.42	.82	73	.66
VI Reasons	0–3	1.23	.94	150	.76	1.19	.90	103	.68	1.36	.91	97	.75	1.27	.90	73	.69
VI Unrelated Thoughts	0–3	.92	.83	151	.88	.92	.85	102	.89	.88	.87	97	.92	.91	.81	73	.93
VI Postponing Training	0–3	1.15	.89	148	.88	.81	.80	102	.90	.94	.79	97	.88	1.08	.96	73	.93
VF Self-Confidence	0–3	1.74	.80	151	.80	2.11	.71	103	.84	1.98	.78	97	.85	1.88	.88	73	.92
Intrinsic Motivation	0–6	2.80	1.49	150	.94	3.36	1.44	98	.94	3.08	1.55	98	.96	3.69	1.58	74	.95
EM Identified Regulation	0–6	2.13	1.33	149	.70	2.43	1.38	100	.78	2.27	1.36	98	.79	2.81	1.30	74	.78
EM Introjected Regulation	0–6	3.62	1.53	150	.77	3.95	1.42	99	.83	4.30	1.35	98	.81	4.91	1.38	74	.76
EM External Regulation	0–6	1.76	1.51	152	.77	2.06	1.57	101	.84	2.01	1.66	98	.89	2.81	1.40	74	.82

Note. BMI = body mass index; VF = volitional facilitation; VI = volitional inhibition; EM = extrinsic motivation.

Table 2
Correlations Between Psychological Predictors at Baseline

Predictors	1	2	3	4	5	6	7	8	9
1. VF Coping With Failure	1								
2. VI Approval From Others	−.34**	1							
3. VI Reasons	−.24**	.25**	1						
4. VI Unrelated Thoughts	−.40**	.31**	.27**	1					
5. VI Postponing Training	−.46**	.20*	.41**	.38**	1				
6. VF Self-Confidence	.69**	−.33**	−.34**	−.24**	−.57**	1			
7. Intrinsic Motivation	.20*	.08	−.05	.04	−.33**	.44**	1		
8. EM Identified Regulation	.04	.25**	−.02	.20*	−.21*	.25**	.65**	1	
9. EM Introjected Regulation	−.07	.27**	.28**	.13	.02	.06	.40**	.40**	1
10. EM External Regulation	−.13	.48**	.16	.22**	.10	.00	.35**	.58**	.43**

Note. VF = Volitional Facilitation; VI = Volitional Inhibition; EM = Extrinsic Motivation.
* $p < .05$. ** $p < .01$.

Separate mixed model analysis revealed that the four volitional factors—VI Approval From Others, VI Reasons, VI Unrelated Thoughts, and VI Postponing Training—positively predicted BMI (when volitional inhibition increases, BMI increases). VF Self-Confidence and Intrinsic Motivation negatively predicted BMI. A significant time interaction was found for VF Self-Confidence, VF Coping With Failure, and EM Identified Regulation, so that an increase in the psychological factor led to a decrease in BMI at T4. A significant time interaction was found for VI Reasons, VI Unrelated Thoughts, VI Postponing Training and EM Introjected Regulation so that an increase in the psychological factor led to an increase in BMI at T4. For VI Unrelated Thoughts, a significant difference was also found at the 3-month follow-up point (T3; see Table 4).

Stepwise Backward Elimination Multiple Mixed Model Analysis

A stepwise backward elimination multiple mixed model analysis was conducted; the time interactions of the predictors were eliminated first, beginning with the highest *p* value. Second, the predictors were eliminated, beginning with the highest *p* value. A summary can be found in Table 5. The final model included one predictor contributing with a negative main effect, VF Self-Confidence ($\beta = -0.51$), and one predictor with a positive main effect, VI Postponing Training ($\beta = 0.59$). Three predictors contributed with a time interaction effect. Parameter estimates for the time interaction of VI Unrelated Thoughts and EM Introjected Regulation revealed that the effects at T3 and T4 were significantly different compared with the effect at T1. Parameter estimates for the time interaction of EM Identified Regulation showed that the effect was significantly different at T2, T3, and T4 compared with the effect at T1. With all three interactions, the effect increased as the distance from baseline grew larger (see Table 6).

Discussion

The current study addressed several important gaps in the literature with regard to the role of exercise-specific psychological constructs for exercise participation and weight loss maintenance in the crucial period following an ILI. Further, the study is the first to investigate exercise-specific volition and motivation in the same study, thereby covering all four phases of the Rubicon model of action phases (Heckhausen, 1991). The study provides evidence

Table 3
Separate Mixed Model Analysis With Exercise Participation as Outcome for Each Psychological Predictor Without and With Time Interaction Controlling for Gender, Age, and Education

	Separate mixed model analysis without time interaction		Separate mixed model analysis with time interaction	
Psychological predictor	Type III *p* value	β [95% CI]	Type III *p* value interaction	β interaction predictor and T4 [95% CI]
VF Coping With Failure	<.01	.62 [.35, .88]	.02	.63 [.11, 1.14]
VI Approval From Others	.596	−.08 [−.37, .21]	.83	.05 [−.42, .53]
VI Reasons	<.01	−.30 [−.52, −.08]	.048	−.43 [−.85, −.01]
VI Unrelated Thoughts	.01	−.33 [−.59, −.08]	.06	−.45 [−.96, .03]
VI Postponing Training	<.01	−.81 [−1.01, −.61]	.01	−.51 [−.89, −.12]
VF Self-Confidence	<.01	.73 [.49, .97]	.03	.49 [.06, .93]
Intrinsic Motivation	<.01	.39 [.26, .52]	.04	.26 [.01, .51]
EM Identified Regulation	<.01	.43 [.28, .58]	<.01	.47 [.18, .75]
EM Introjected Regulation	<.01	.20 [.05, .34]	.80	−.04 [−.33, .25]
EM External Regulation	<.01	.21 [.06, .36]	.03	.29 [.03, .56]

Note. For interaction terms, reference time is baseline (Time 1). CI = confidence interval; T4 = Time 4; VF = Volitional Facilitation; VI = Volitional Inhibition; EM = Extrinsic Motivation.

Table 4
Separate Mixed Model Analysis With BMI as Outcome for Each Psychological Predictor Without and With Time Interaction Controlling for Gender, Age, and Education

	Separate mixed model analysis without time interaction		Separate mixed model analysis with time interaction			
Psychological predictor	Type III *p* value	β [95% CI]	Type III *p* value interaction	β interaction predictor at T2 [95% CI]	β interaction predictor at T3 [95% CI]	β interaction predictor at T4 [95% CI]
VF Coping With Failure	.38	−.24 [−.80, .31]	<.01	−.1 [−1.0, .083]	−.66 [−1.68, .36]	−1.71** [−2.66, .77]
VI Approval From Others	.03	.57* [.06, 1.09]	.42	−.11 [−.87, .65]	.15 [−.66, .96]	.61 [−.23, 1.44]
VI Reasons	.02	.47* [.07, .88]	<.01	.16 [−.17, 1.36]	.6 [−.17, 1.36]	1.50** [.76, 2.24]
VI Unrelated Thoughts	.02	.50* [.08, .92]	<.01	.5 [−.26, 1.26]	.88* [.06, 1.70]	2.78** [1.94, 3.62]
VI Postponing Training	<.01	.94** [.50, 1.38]	<.01	.23 [−.50, .97]	.49 [−.34, 1.32]	1.67** [.94, 2.40]
VF Self-Confidence	<.01	−.81** [−1.27, −.35]	<.01	.06 [−.81, .38]	−.59 [−1.47, .28]	−1.64** [−2.46, −.81]
Intrinsic Motivation	<.01	−.49** [−.77, −.21]	.20	−.02 [−.45, .41]	.04 [−.41, .50]	−.44[a] [−.89, .02]
EM Identified Regulation	.25	−.18 [−.48, .13]	<.01	−.17 [−.63, .29]	−.16 [−.65, .29]	−.92** [−1.46, −.39]
EM Introjected Regulation	.09	−.23 [−.49, .04]	.01	.30 [−.13, .73]	.40 [−.10, .90]	.84** [.34, 1.35]
EM External Regulation	.98	.00 [−.28, .29]	.44	−.09 [−.43, .31]	.01 [−.43, .45]	−.38 [−.86, .11]

Note. For interactions, reference time is baseline (Time 1). BMI = body mass index; CI = confidence interval; T = Time; T2 = 14-week postintervention; T3 = 3-month follow-up; T4 = 12-month follow-up; VF = Volitional Facilitation; VI = Volitional Inhibition; EM = Extrinsic Motivation.
* $p < .05$. ** $p < .01$.
[a] $p = .06$.

that exercise participation as well as exercise-specific volition and motivation are prospectively associated with BMI in the expected directions across a 3-month ILI as well as in the 12-month period following the intervention. Furthermore, both exercise-specific volition and motivation predict exercise participation in the 3-month period of the intervention and the following 12 months after the intervention. The study looked at a pattern of significance and the *p* values were only suggestive of significance in the population. This means that the results will need to be replicated in a larger sample in order to be able to statistically refer the results to the larger population; however, given that this is the first study to combine these psychological constructs, the initial findings were interesting.

Analysis of the psychological scales revealed that the volitional scales VI Reasons, VI Unrelated Thoughts, VI Postponing Training, and VF Self-Confidence had an overall effect on BMI, and the effect was significantly stronger at the 12-month follow-up point. For VI Unrelated Thoughts, the effect was also significantly stronger at the follow-up point 3 months after the intervention. The overall effect means that these psychological constructs affect an individual's weight loss process through an ILI, and the fact that the effect is stronger at the 3-month and 12-month follow-up

Table 5
Backward Stepwise Elimination Mixed Models With BMI as Outcome While Controlling for Gender, Age, and Education

Predictor	Step	*p* value eliminated	Final model *p* values
VF Coping With Failure	6	.80	
Interaction with time	2	.86	
VI Approval From Others	9	.12	
VI Reasons	7	.39	
Interaction with time	3	.46	
VI Unrelated Thoughts			.17
Interaction with time			<.01
VI Postponing Training			.01
Interaction with time	1	.92	
VF Self-Confidence			.03
Interaction with time	4	.35	
Intrinsic Motivation	8	.14	
Interaction with time	5	.06	
EM Identified Regulation			.71
Interaction with time			<.01
EM Introjected Regulation			.98
Interaction with time			<.01

Note. First, interactions were removed from the model beginning with the highest *p* value until all interactions in the model were significant. Second, individual predictors were removed from the model beginning with the highest *p* value until all remaining in the model were significant. BMI = body mass index; VF = Volitional Facilitation; VI = Volitional Inhibition; EM = Extrinsic Motivation.

Table 6
Parameter Estimates of Significant Predictors in Step 3 of the Backward Elimination Mixed Model Analysis With BMI as Outcome

Predictor	β [95% CI]	*SE*	*p*
VF Self-Confidence	−.51 [−.97, −.05]	.23	.03
VI Postponing Training	.59 [.12, 1.05]	.24	.01
VI Unrelated Thoughts interaction at T2	.55 [−.22, 1.32]	.39	.16
VI Unrelated Thoughts interaction at T3	.92 [.11, 1.72]	.41	.03
VI Unrelated Thoughts interaction at T4	2.53 [1.70, 3.36]	.42	.00
EM Identified interaction at T2	−.52 [−.96, −.07]	.23	.02
EM Identified interaction at T3	−.77 [−1.26, −.27]	.25	.00
EM Identified interaction at T4	−1.19 [−1.71, −.67]	.26	.00
EM Introjected interaction at T2	.38 [−.03, .79]	.21	.07
EM Introjected interaction at T3	.69 [.21, 1.17]	.24	.01
EM Introjected interaction at T4	.94 [.44, 1.43]	.25	.00

Note. For interaction terms, reference time is baseline (Time 1). Variables in model included because interaction is significant but not shown: VI unrelated thoughts, EM identified, EM introjected. Variables in model included to control for but not shown: gender, age, and education. BMI = body mass index; CI = confidence interval; *SE* = standard error; VF = Volitional Facilitation; VI = Volitional Inhibition; EM = Extrinsic Motivation.

points indicates that they are of special importance for weight loss maintenance in the period following the ILI. VI Approval from others and Intrinsic Motivation showed only an overall effect on participants' BMI, which means that these constructs are important to weight loss through an ILI but not more important for weight loss maintenance in the period following an ILI than during. VF Coping With Failure, EM Identified Regulation, and EM Introjected Regulation did not show an overall effect, however, but an effect at the follow-up point 12 months after the intervention. This indicates that they are important for weight loss maintenance in the period after the ILI when the individual has to maintain the obtained weight loss in his or her "natural" environment, but not for the weight loss process in general. Finally, a mixed model with all psychological variables revealed that, above and beyond the other constructs, the volitional scales VI Postponing Training and VF Self-Confidence had a main effect, whereas VI Unrelated Thoughts, EM Identified Regulation, and EM Introjected Regulation were important over time. A multiple backward elimination mixed model analysis revealed that the scales VF Self-Confidence and VI Postponing Training had an effect even when controlling for the other scales, meaning that they provide unique information above and beyond them. Similarly the scales VI Unrelated Thoughts, EM Identified Regulation, and EM Introjected Regulation provided a unique interaction effect across time.

Additional analysis with exercise participation confirmed previous findings of exercise-specific volition (Elsborg et al., 2017) and exercise-specific autonomous motivation (Teixeira, Carraça, Markland, Silva, & Ryan, 2012) as sound predictors of participation in exercise, and that participation in exercise is a sound predictor of weight loss maintenance for individuals battling obesity (Haslam & James, 2005). The novelty of this study is that both motivational and volitional factors were included in the same study to predict this.

The findings of this study suggest that exercise-specific volition has an effect on weight loss through an ILI both in general and as a facilitator of weight loss maintenance in the period following the intervention. The multiple mixed model even suggests that, overall, the effect of volitional scales VI Postponing Training and VF Self-Confidence was above and beyond that of the other psychological scales included in this study. This suggests that these volitional aspects are more important for weight loss maintenance than motivational constructs of self-determination theory. These results corroborate the findings of the role of volitional skills with regard to performance level in elite sports (Elbe et al., 2005; Wenhold et al., 2009). To our knowledge, this is the first study investigating the effects of exercise-specific volitions' role in the process of weight loss maintenance.

Our findings with regard to motivation provide an important extension to previous research on nonintensive weight loss interventions (Teixeira et al., 2015) by demonstrating that the construct intrinsic motivation is also important for both weight loss maintenance during an ILI and in the period following the intervention. Another finding in this study was that EM Identified Regulation showed a significantly different effect at the 12-month follow-up point on weight loss maintenance, whereas EM Introjected Regulation showed a significant effect in the opposite direction at the 12-month follow-up point on weight loss maintenance in the period following an ILI. *Identified regulation* is defined as an acceptance "of the underlying value of a behavior," whereas *introjected regulation* is described as "regulations that are within the person, but still relatively external to the self" (Deci & Ryan, 2000, p. 36). With these definitions in mind, the results of this study indicate that extrinsic motivation has an impact when the underlying value of participation in exercise is accepted, whereas an internalization of external regulations can be counterproductive in the long term.

There were both strengths and limitations of the present study. One strength was that it investigated an ILI with professional staff and with committed participants who invested a significant amount of their own time and money in order to participate. Another strength is that the ILI is an existing intervention already embedded in society. Limitations of this study include that the sample size was fixed, and given the ratio between the number of predictors and the sample size, there was a risk of the study being underpowered. In such a situation, there is the risk of overfitting the data and a risk that the statistical model becomes overly sensitive to minor fluctuations in the data, and thus describes the random error in the data rather than the underlying relationships. Having said this, and given the fact that it was acknowledged that the study was of exploratory nature, it is clear that the study needs to be replicated in a larger sample. Furthermore, the self-reported weight in the follow-up period could also be a limitation, as some studies have shown that self-reporting weight is connected to measurement errors (Rowland, 1990). Another limitation is that exercise activity was assessed only via one item and assessed only at the 12-month and not at the 3-month follow-up. In addition, another limitation is that the reliability of the scales VI Approval From Others and VI Reasons was only borderline acceptable at two of the measurement points. As a necessity primarily because of limited resources for the study, self-reported weight and questionnaire-measured exercise participation was used. Future research should investigate this with objective weight measures as well as with either a validated instrument for measuring exercise participation or objectively measured physical activity through accelerometers or GPS.

Overall, our findings indicate that exercise-specific volition and self-determined motivation may be particularly beneficial for establishing that an ILI has a long-lasting effect on weight loss. These findings may have a number of important practical implications for both individuals, with the goal of overcoming obesity, and interventions staff designed to assist people with obesity to obtain and maintain weight loss. The most important practical recommendation from the results of this study is that an intervention should incorporate both training in volitional abilities and developing autonomous exercise motivation. Working with implementation intentions, for example, has shown to positively impact volitional skills (Gollwitzer & Brandstätter, 1997). At the same time, it is important to ensure that individuals develop their motivation toward exercise to the extent that they accept their exercise activity's underlying value. Here, research suggests that sampling different exercise activities in a task-oriented environment stimulates the development of autonomous motivation (Edmunds, Ntoumanis, & Duda, 2007).

Conclusion

This study has shown that exercise-specific volition and motivation influence the task of weight loss maintenance following an

ILI. The results of the study indicate that exercise volition and, in particular, volitional self-confidence and the tendency to postpone training are of importance above and beyond the previous sound predictor, autonomous exercise motivation of weight loss maintenance. Results of the study also indicate that extrinsic motivation can be either facilitating or counterproductive depending on the level of self-determination, as identified regulation showed a positive effect 12 months after the intervention, whereas internal regulation showed a negative effect on weight loss. More research on how to influence exercise-specific volition in individuals battling obesity is needed.

References

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist, 44,* 1175–1184. http://dx.doi.org/10.1037/0003-066X.44.9.1175

Christiansen, T., Bruun, J. M., Madsen, E. L., & Richelsen, B. (2007). Weight loss maintenance in severely obese adults after an intensive lifestyle intervention: 2- to 4-year follow-up. *Obesity, 15,* 413–420. http://dx.doi.org/10.1038/oby.2007.530

Colley, R. C., Hills, A. P., O'Moore-Sullivan, T. M., Hickman, I. J., Prins, J. B., & Byrne, N. M. (2008). Variability in adherence to an unsupervised exercise prescription in obese women. *International Journal of Obesity, 32,* 837–844. http://dx.doi.org/10.1038/sj.ijo.0803799

Dandanell, S. (2016). *Physiological factors that influence weight loss maintenance after a lifestyle intervention* (Unpublished doctoral dissertation). University of Copenhagen, Copenhagen, Denmark.

Dandanell, S., Ritz, C., Verdich, E., Dela, F., & Helge, J. W. (2017). Repeated lifestyle interventions lead to progressive weight loss: A retrospective review chart study. *Scandinavian Journal of Public Health, 45,* 305–313. http://dx.doi.org/10.1177/1403494817693709

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11,* 227–268. http://dx.doi.org/10.1207/S15327965PLI1104_01

Drewnowski, A. (2009). Obesity, diets, and social inequalities. *Nutrition Reviews, 67* (Suppl. 1), S36–S39. http://dx.doi.org/10.1111/j.1753-4887.2009.00157.x

Edmunds, J., Ntoumanis, N., & Duda, J. L. (2007). Adherence and well-being in overweight and obese patients referred to an exercise on prescription scheme: A self-determination theory perspective. *Psychology of Sport and Exercise, 8,* 722–740. http://dx.doi.org/10.1016/j.psychsport.2006.07.006

Elbe, A.-M., Szymanski, B., & Beckmann, J. (2005). The development of volition in young elite athletes. *Psychology of Sport and Exercise, 6,* 559–569. http://dx.doi.org/10.1016/j.psychsport.2004.07.004

Elsborg, P., Wikman, J. M., Nielsen, G., Tolver, A., & Elbe, A.-M. (2017). Development and initial validation of the Volition in Exercise Questionnaire (VEQ). *Measurement in Physical Education and Exercise Science, 21,* 57–68. http://dx.doi.org/10.1080/1091367X.2016.1251436

Gollwitzer, P. M., & Brandstätter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology, 73,* 186–199. http://dx.doi.org/10.1037/0022-3514.73.1.186

Gollwitzer, P. M., & Oettingen, G. (2012). Goal pursuit. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (pp. 208–231). New York, NY: Oxford University Press. http://dx.doi.org/10.1093/oxfordhb/9780195399820.013.0013

Haslam, D. W., & James, W. P. T. (2005). Obesity. *The Lancet, 366,* 1197–1209. http://dx.doi.org/10.1016/S0140-6736(05)67483-1

Heckhausen, H. (1991). *Motivation and action*. Berlin, Germany: Springer. http://dx.doi.org/10.1007/978-3-642-75961-1

Kuhl, J. (1992). Motivation and volition. In G. d'Ydewalle, P. Eelen, & P. Bertelson (Eds.), *International perspectives on psychological science* (Vol. 2, pp. 331–340). Hove, UK: Erlbaum.

Kuhl, J. (2000). The volitional basis of personality systems interaction theory. *International Journal of Educational Research, 33,* 665–703. http://dx.doi.org/10.1016/S0883-0355(00)00045-8

Kutner, M. H., Nachtsheim, C. J., & Neter, J. (2004). *Applied linear regression models – 4th edition with student CD*. Boston, MA: McGraw-Hill Education.

McTigue, K. M., Hess, R., & Ziouras, J. (2006). Obesity in older adults: A systematic review of the evidence for diagnosis and treatment. *Obesity, 14,* 1485–1497. http://dx.doi.org/10.1038/oby.2006.171

Ochner, C. N., Barrios, D. M., Lee, C. D., & Pi-Sunyer, F. X. (2013). Biological mechanisms that promote weight regain following weight loss in obese humans. *Physiology & Behavior, 120,* 106–113. http://dx.doi.org/10.1016/j.physbeh.2013.07.009

Pelletier, L. G., Fortier, M. S., Vallerand, R. J., Tuson, K. M., Briere, N. M., & Blais, M. R. (1995). Toward a new measure of intrinsic motivation, extrinsic motivation, and amotivation in sports: The Sport Motivation Scale (SMS). *Journal of Sport & Exercise Psychology, 17,* 35–53. http://dx.doi.org/10.1123/jsep.17.1.35

Rolls, B. J., Fedoroff, I. C., & Guthrie, J. F. (1991). Gender differences in eating behavior and body weight regulation. *Health Psychology, 10,* 133–142. http://dx.doi.org/10.1037/0278-6133.10.2.133

Rowland, M. L. (1990). Self-reported weight and height. *The American Journal of Clinical Nutrition, 52,* 1125–1133. http://dx.doi.org/10.1093/ajcn/52.6.1125

Silva, M. N., Markland, D., Carraça, E. V., Vieira, P. N., Coutinho, S. R., Minderico, C. S., . . . Teixeira, P. J. (2011). Exercise autonomous motivation predicts 3-yr weight loss in women. *Medicine and Science in Sports and Exercise, 43,* 728–737. http://dx.doi.org/10.1249/MSS.0b013e3181f3818f

Slovinec D'Angelo, M. E., Pelletier, L. G., Reid, R. D., & Huta, V. (2014). The roles of self-efficacy and motivation in the prediction of short- and long-term adherence to exercise among patients with coronary heart disease. *Health Psychology, 33,* 1344–1353. http://dx.doi.org/10.1037/hea0000094

Streiner, D. L. (2003). Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment, 80,* 99–103. http://dx.doi.org/10.1207/S15327752JPA8001_18

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *The International Journal of Behavioral Nutrition and Physical Activity, 9,* 78. http://dx.doi.org/10.1186/1479-5868-9-78

Teixeira, P. J., Carraça, E. V., Marques, M. M., Rutter, H., Oppert, J.-M., De Bourdeaudhuij, I., . . . Brug, J. (2015). Successful behavior change in obesity interventions in adults: A systematic review of self-regulation mediators. *BMC Medicine, 13,* 84. http://dx.doi.org/10.1186/s12916-015-0323-6

Wenhold, F., Elbe, A.-M., & Beckmann, J. (2009). Testgütekriterien des Fragebogens VKS zur Erfassung volitionaler Komponenten im Sport [Test control criteria for the VKS - a questionnaire assessing volitional components in sport]. *Zeitschrift für Sportpsychologie, 16,* 91–103. http://dx.doi.org/10.1026/1612-5010.16.3.91

Wing, R. R., & Hill, J. O. (2001). Successful weight loss maintenance. *Annual Review of Nutrition, 21,* 323–341. http://dx.doi.org/10.1146/annurev.nutr.21.1.323

World Health Organization. (2013, March 1). Obesity and overweight. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/

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