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BRIEF REPORT

Intrinsic Motivation in Two Exercise Interventions: Associations With Fitness and Body Composition

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Objective: To examine the motivational process through which increases in aerobic capacity and decreases in total body fat are achieved during high-intensity intermittent training (HIT) and moderate-intensity continuous training (MICT) interventions. ***Method:*** Eighty-seven physically inactive adults (65% women, age = 42 ± 12, BMI = 27.67 ± 4.99 kg/m^2) took part in a 10-week randomized intervention testing group-based HIT, operationalized as repeated sprints of 15–60 s interspersed with periods of recovery cycling ≤ 25 min/session, 3 sessions/wk^{-1}, or MICT, operationalized as cycling at constant workload of ~65% maximum aerobic capacity (VO_{2max}, 30–45 min/session^{-1}, 5 sessions/wk^{-1}. Assessments of VO_{2max} and total body fat were made pre- and postintervention. Motivation variables were assessed midintervention and class attendance was monitored throughout. Path analysis was employed, controlling for treatment arm and baseline values of VO_{2max} and total body fat. ***Results:*** The 2 groups differed in adherence only, favoring HIT. Baseline VO_{2max} predicted intrinsic motivation midintervention. Intrinsic motivation predicted program adherence, which in turn predicted increases in VO_{2max} and decreases in total body fat by the end of the study. ***Conclusion:*** Intrinsic motivation in HIT and MICT is positively linked to adherence to these programs, which can facilitate improvements in fitness and body composition.

Keywords: self-determination, VO_{2max}, body fat, HIT, path analysis

High-intensity intermittent training (HIT) has been suggested as a training modality that can address the commonly reported time barrier (Stutts, 2002). This type of training appears effective in inducing health and fitness improvements in laboratory-based studies (e.g., Gibala, Little, MacDonald, & Hawley, 2012). However, the motivational processes associated with this type of exercise intervention have not been examined. In the present study, we investigate the extent to which gains in aerobic exercise capacity (e.g., fitness) and aesthetic changes in body composition (e.g., decreases in adiposity), which are two of the most commonly reported reasons for initiating exercise among the general adult population (European Commission, 2014), are predicted by exercise adherence, and whether the latter is more likely to be predicted by certain types of exercise motivation.

Self-determination theory (SDT; Deci & Ryan, 1985) is a macromotivational approach that has been employed to explore the importance of different types of motivation in predicting diverse behavioral, affective, and cognitive outcomes across a range of life settings, including exercise (Ng et al., 2012; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Self-determined motivation is characterized by intrinsic motivation (engaging in the activity because of the inherent enjoyment associated with it), integrated regulation, because the activity is aligned with the individual's identity or personal values, and identified regulation (the individ-

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ual engages in the activity because he or she values the associated outcomes). Non-self-determined motivation includes introjection (taking part in an activity due to feelings of guilt) and external regulation (engaging in the activity due to external pressures). Last, amotivation refers to the absence of any type of motivation. One recent meta-analysis (n = 184 studies) conducted by Ng and colleagues (2012) revealed significant unique effects of self-determined motivation on physical health (e.g., exercise, diet, glycemic control). Specific to the exercise context, Teixeira et al. (2012) systematically reviewed 66 studies. The results suggested that identified regulation was a stronger predictor of short-term exercise adoption and that intrinsic motivation was the strongest predictor of long-term adherence. Mixed and no significant results were revealed for the non-self-determined regulations. However, both reviews point to important limitations of this research, including a reliance on cross-sectional evidence, and relative lack of objectively assessed health outcomes. Indeed, Teixeira et al. (2012) highlighted the need to include biological markers, including fitness and disease risk factors. To our knowledge, the role of self-determined regulations in predicting maximal aerobic capacity has not been explored within the context of a randomized controlled trial, and body-composition outcomes have only been explored in relation to body weight, but not fat loss (Silva et al., 2011).

In this study we examined a process model involving the various motivation regulations proposed by SDT, exercise adherence, and physical health outcomes (e.g., VO_{2max} and body fat). Controlling for training condition (high vs. moderate intensity) and baseline levels of each outcome, we hypothesized significant associations between self-determined motivation and adherence, but no significant paths between controlled motivation and amotivation with adherence. Adherence was expected to predict postintervention scores of the two outcomes. The paths from adherence were expected to be positive for VO_{2max} and negative for body fat.

Method

Participants and Procedure

This is a secondary analysis of a randomized, controlled trial study which examined the effects of HIT on a range of cardiovascular, metabolic, psychological, and physical activity outcomes (Shepherd et al., 2015). In the present study, we specifically investigated the unique contribution of motivation regulations to adherence and changes in aerobic exercise capacity (VO_{2max}) and body composition (decreases in adiposity).

Flyers advertised the program to staff members at a large British University, targeting individuals who wished to become more physically active. Eighty-seven staff members (65% women, M age = 42.45, SD = 12, age range = 23–60) consented to take part in the intervention. Mean body-mass index (BMI) was 27.67 (SD = 4.87; 65.90% were overweight or obese). Eligible participants were ≥18 years of age, healthy (i.e., free of any metabolic or cardiovascular disease) and physically inactive (i.e., they did not meet the recommendation of physical activity for health set by the World Health Organisation, as assessed using the short form of the International Physical Activity Questionnaire; Craig et al., 2003). Any combinations of vigorous and moderate-intensity physical activity were taken into account in making that judgment.

Participants were randomized to one of two arms: HIT or moderate-intensity continuous exercise training (MICT). The intervention was 10 weeks long, class-based, led by a team of five experienced fitness instructors, and took place in a cycle suite at a university sports center. Group training was performed on mechanically braked spinning bikes (Star Trac UK, Ltd., Buckinghamshire, UK). Each participant was provided with individual heart-rate target values, determined from the results of the VO_{2max} test, to achieve during the exercise sessions.

Participants assigned to the HIT condition performed repeated high-intensity sprints (15–60 s in duration), interspersed with periods of active recovery (60–120 s in duration). Participants were provided with a heart-rate monitor (Polar Team 2, Polar Electro Ltd., Warwick, UK) and individual heart-rate values were projected on to a screen at the front of the room. For each high-intensity sprint, the participants were instructed to manually adjust the resistance of the bike and pedal at a cadence that elicited a heart rate equivalent to >90% VO_{2max}. Participants were advised to lower/remove the fly-wheel resistance during recovery periods. Participants randomized to the MICT condition were provided with a heart-rate monitor (RS400, Polar Electro Ltd., Warwick, UK) and were instructed to exercise at a heart rate equivalent to ~65% VO_{2max}. Exercise duration progressed from 20 to 40 min through the course of the intervention.

Participants in both groups were asked to attend three supervised exercise sessions per week; in addition, those in the MICT condition were asked to perform two additional unsupervised moderate-intensity exercise sessions per week, which consisted of brisk walking, jogging, cycling, or elliptical cross training, to align with physical activity guidelines for health. Heart-rate monitors were also worn for unsupervised exercise sessions and training diaries were completed. Full trial details have been reported elsewhere (Shepherd et al., 2015).

Measurement

Aerobic capacity and body composition measures were taken pre- and postintervention. Motivational regulations were assessed following an exercise session during Week 5 and adherence (measured via attendance records) was monitored throughout the intervention.

Aerobic capacity. This was represented via VO_{2max} scores. The participants initially performed a progressive maximal exercise test (VO_{2max} test) on an electronically braked cycle ergometer (Lode BV, Groningen, the Netherlands) using an online gas collection system (Oxycon Pro, Jaeger, Germany). The test consisted of sequential increments of 35 W every 3 min until volitional exhaustion. VO_{2max} was determined as the average VO_2 value obtained in the last 30 s of the test. VO_{2max} was considered to be valid when heart rate was greater than 90% of the age-predicted heart-rate maximum (calculated as 220 – age) and the respiratory exchange ratio (RER) was greater than 1.10.

Body composition. To estimate percentage total body fat pre- and postintervention, a single frequency bioimpedance device (Tanita BC 418 MA Segmental Body Composition Analyzer, Tanita, Japan) was used. Studies have shown that there are no significant differences between bioelectrical impedance analysis (BIA) and underwater weighing (Utter, Nieman, Ward, & Butterworth, 1999) or between BIA and dual energy X-ray absorptiometry (DXA; Pateyjohns, Brinkworth, Buckley, Noakes, & Clifton, 2006). This indicates there is a good relative agreement between BIA and other recognized measures of body composition.

Exercise motivation. The Behavioral Regulation in Exercise Questionnaire–2 (Markland & Tobin, 2004) was employed as a measure of exercise motivation. The scale includes subscales measuring Intrinsic Motivation, Identified Regulation, Introjected Regulation, External Regulation, and Amotivation. All items are measured on 5-point scales, ranging from 0 (*not true for me*) to 4 (*very true for me*). The subscales for Intrinsic Motivation (α = .92), External Regulation (α = .71), and Amotivation (α = .70) were internally consistent, but the α reliability coefficients for the Identified (α = .37) and Introjected (α = .51) subscales were very low. This could be due to the fact that each of the latter two subscales had three items, whereas the other subscales had four items. For Identified Regulation, the fourth item was inadvertently left out.

Adherence. Adherence was assessed via attendance records kept by a member of the research team and was calculated as the percentage of prescribed exercise sessions attended (i.e., a percentage is derived from the number of sessions attended from the overall number of sessions available in each group). Attendance was monitored throughout the intervention.

Data Analysis

All analyses were conducted using intention-to-treat (ITT) analyses with the baseline-value-carried-forward (BVCF) principle. There was no pattern in the missing data as visually inspected, and as determined by Little's missing-completely-at-random test: $\chi^2(43) = 53.18$, $p = .14$. We used ITT because it is a conservative estimation method in the presence of missing data. We also used a full-information maximum likelihood method, which is considered superior to other imputation methods for missing data (Enders & Bandalos, 2001), and the fit indices and parameter coefficients were very similar to those from the ITT analysis. Path analysis using EQS 6.2; Multivariate Software, Inc., Encino, CA was employed to examine a process model. The model specified paths from baseline values of the outcomes (VO_{2max} and % body fat) to intrinsic motivation, extrinsic motivation and amotivation. Paths were also specified from these motivation variables to adherence, and from adherence to postintervention scores of the two outcomes. The model also specified directional paths from the condition (0 = MICT, 1 = HIT) to three types of motivation, adherence and the postintervention outcomes. Finally, a path from the baseline value of each outcome to its postintervention value was also included.

Results

Repeated-measures ANOVAs showed increases in VO_{2max}, $F(1, 84) = 78.70$, $p < .01$, partial $\eta^2 = .48$, and decreases in body fat, $F(1, 79) = 16.06$, $p < .01$, partial $\eta^2 = .17$, in both groups; there were no group or Group $\times$ Time differences. The results of the path analysis are displayed in Figure 1. The model showed an excellent fit to the data: $\chi^2(12) = 13.85$, $p = .31$, comparative fit index (CFI) = .99, nonnormed fit index (NNFI) = 1, standardized root-mean-square residual (SRMR) = .05; root-mean-square error of approximation (RMSEA) = .04. Baseline fitness positively predicted intrinsic motivation and negatively predicted external regulation. Intrinsic motivation was a positive predictor of lower body-fat percentage and adherence, which in turn predicted greater fitness postintervention. Body-fat percentage at baseline did not predict any motivational regulation. The only significant difference between the two groups was in adherence, which was higher in the HIT group. We decided not to include identified regulation and introjected regulation in the model because both variables had very low reliability. As a result of the review process, we ran models with these two variables as well. The results for identified regulation paralleled those for intrinsic motivation in that identified regulation was a significant predictor of adherence, although the path coefficient was much weaker than the path coefficient for intrinsic motivation to adherence. Equally, the results for introjected regulation paralleled those for external regulation and amotivation, in that introjected regulation was not a significant pre-

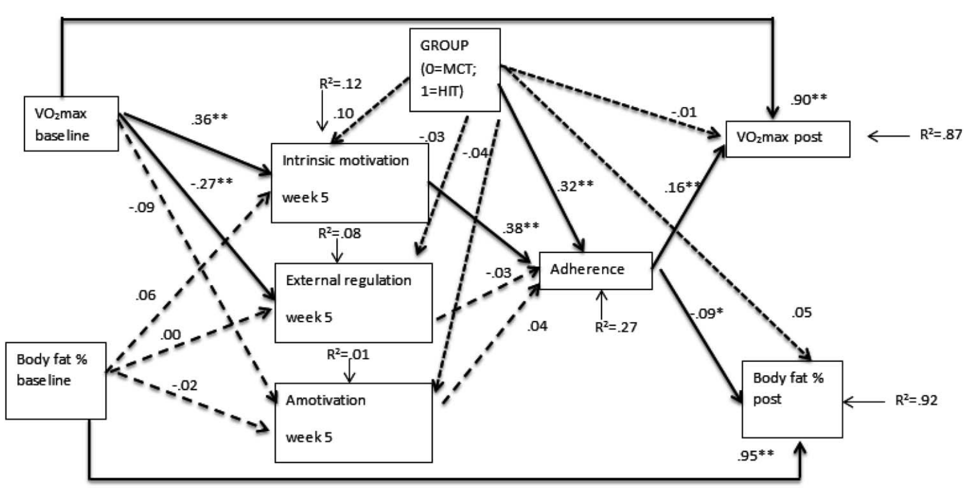

Figure 1. Process models of intrinsic motivation, extrinsic motivation, amotivation, adherence, aerobic capacity, and body-fat percentage. We correlated the three motivational variables, as well as the two physiological variables at each time point. We do not show these coefficients for purposes of presentation simplicity. * $p < .05$. ** $p < .01$.

dictor of adherence. Following a request from a reviewer, we also controlled for BMI, age, and gender in the model. The model also showed an excellent fit to the data: $\chi^2(21) = 13.26$, $p = .90$, CFI = 1, NNFI = 1, SRMR = .04, RMSEA = .00. A number of differences in the variables emerged as a function of gender, age, and BMI, but the substantive interpretations from the model did not change (i.e., the significance of the path coefficients in Figure 1 did not change and the size of the coefficients changed marginally).

Discussion

The present study explored a motivational model linking exercise motivation, aerobic capacity, and total body fat in two types of exercise intervention, HIT and MICT. Similar to studies examining the motivational process underlying other types of exercise programs (Teixeira et al., 2012), self-determined motivation, and especially intrinsic motivation, were key predictors of adherence, which in turn predicted desirable changes in physiological outcomes (VO_{2max} and total body fat). Consistent with theory and previous research, external regulation and amotivation did not predict adherence. The findings support tenets of SDT (Deci & Ryan, 1985) and provide much-needed longitudinal evidence as the majority of evidence linking self-determined motivation in exercise and health outcomes has been cross-sectional (Teixeira et al., 2012). Further, the study addresses another important limitation of previous SDT-related research in that it examined the role of self-determined motivation to biological markers of fitness and health risks, another point emphasized in the systematic review by Teixeira et al., 2012.

The motivation literature has generally considered how motivation predicts adherence and various health outcomes. However, our study contributes to motivation research by showing that the reverse pattern is also possible, in that participants' aerobic fitness at baseline predicted their motivation during the exercise intervention. This implies that fitter individuals were more likely to be intrinsically motivated to participate in the exercise program, and this ensuing motivation predicted adherence and physiological outcomes. This result aligns with previous findings showing that less fit individuals may be less likely to adhere to exercise programs (e.g., King et al., 1997). Nonetheless, the prediction was far from perfect, which means that even unfit adults can adhere to and gain positive health benefits from HIT and MICT training if intrinsic motivation can be fostered.

A limitation of this study is that, despite the different time assessments, covariance of the measures throughout the course of the study could be an alternative explanation for the study results. In future research, it would be interesting to examine how the motivational climate in these classes could be changed to foster intrinsic motivation. It would also be useful in future trials to compare the outcomes of HIT and MICT interventions in which feelings of intrinsic motivation and self-determination are actively fostered against conditions in which self-determination is not targeted. It is also important to examine other factors predicting self-determined motivation and adherence such as self-efficacy to complete the programs. In sum, participants in both HIT and MICT interventions may experience greater gains in fitness and body composition if intrinsic motivation can be fostered during the intervention, as this motivation promotes adherence to the interventions.

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