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Affective response to exercise as a component of exercise motivation: Attitudes, norms, self-efficacy, and temporal stability of intentions

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Abstract

Problem: A positive affective response is associated with increased participation in voluntary exercise, but the mechanisms by which this occurs are not well known. Consistent with a Theory of Planned Behaviour perspective, we tested whether affective response to exercise leads to greater motivation in terms of attitudes, subjective norms, self-efficacy and intentions to exercise. We were also specifically interested in whether a positive affective response leads to more temporally stable intentions.

Method: Participants (N = 127) self-reported Theory of Planned Behaviour constructs and exercise behavior at baseline and three months later, and provided reports of exercise-related affect during a 30-minute bout of moderate intensity treadmill exercise at baseline.

Results: We show that participants who experience greater improvements in positive affect, negative affect and fatigue during exercise tended to report more positive attitudes, exercise self-efficacy and intentions to exercise three months later. Affective response was not predictive of subjective norms. As hypothesized, positive affective response was associated with more stable intentions over time.

Conclusions: We conclude that a positive affective response to acute bouts of exercise can aid in building and sustaining exercise motivation over time.

Keywords

exercise motivation; affective response; exercise mood states; temporal stability of intentions

Encouraging regular participation in physical activity is a worldwide public health priority (World Health Organization, 2004). The World Health Organization (WHO) has encouraged member nations to develop policies and programs that promote health through diet and physical activity. Yet even the most empirically supported physical activity interventions, such as those based on a primarily rational cognitive perspective, have had limited success, especially when

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predicting behavior maintenance (e.g., Oman & King, 1998). To fulfill the WHO physical activity goals, we need better models for predicting the adoption and maintenance of exercise. Predicting exercise behavior longitudinally requires a transdisciplinary approach (Rosenfield, 1992), including consideration of psychological, behavioral, genetic, and physiological determinants (Dishman et al., 2006; Marcus et al., 2006). One such determinant is likely the subjective experience of exercise (Bryan, Hutchison, Seals, & Allen, 2007).

Acute bouts of exercise can lead to an immediate improvement in positive affect (e.g., increased vigor) and negative affect (e.g., decreased anxiety; Reed, 2005). Increasingly, evidence shows that a positive affective response to exercise contributes to adherence to an exercise regimen (Annesi, 2005a; Carels, Berger, & Darby, 2006; Kwan & Bryan, in press; Williams et al., 2008). Unsurprisingly, it appears that when people feel good as a result of exercising, they are more likely to be regularly physically active, and importantly, to maintain physical activity over the long term. What is less clear is *how* a positive affective response to exercise leads to increased or maintained exercise behavior. Without an understanding of this process, it is impossible to use this information to target intervention content to the affect-exercise behavior relationship. Our thesis in this paper, which has rarely if ever been explored, is that a positive affective response to exercise influences exercise behavior because it serves to enhance and, perhaps more importantly, maintain motivation to exercise.

Various theories have been proposed to explain the relationship between affective response to exercise and maintenance of exercise behavior. According to an operant conditioning account, a positive affective response to exercise would positively reinforce behavior while a negative affective response to exercise would punish behavior (e.g., Annesi, 2005b). According to a hedonic theory account, people are driven to pursue positive hedonic (pleasurable) experiences, and thus participation in exercise would be increased for those who experience positive hedonic emotion as a result of exercise behavior (e.g., Williams et al., 2008). Others have suggested that the affective response – exercise behavior relationship might be further explained by differences in motivation to exercise (Bixby & Lochbaum, 2006; Bryan et al., 2007; Focht, Knapp, Gavin, Raedeke, & Hickner, 2007; Rose & Parfitt, 2007). None of these hypothesized mechanisms have been empirically tested, however. We aim to test the motivation hypothesis in the context of the Theory of Planned Behavior (TPB; Ajzen, 1991). We previously showed, using portions of this dataset, that affective response was prospectively related to exercise behavior (Kwan and Bryan, in press). In this analysis, we specifically focus on a possible mechanism driving this relationship.

The TPB has been shown to be an excellent predictor of exercise behavior specifically (Hagger, Chatizisarantis, & Biddle, 2002) and a wide range of other related health behaviors (Armitage & Conner, 2001; Godin & Kok, 1996). The TPB has been identified as model of behavior change that is primarily motivational in nature (Baban & Craciún, 2007). According to the TPB, behavior is a function of intentions to perform that behavior, and intentions are a function of attitudes, subjective norms, and perceived behavioral control (often conceptualized as self-efficacy) for the behavior. Together, these constructs are said to represent an individuals' overall motivation to perform the behavior. The effects of other predictors of behavior (such as the affective response to the behavior) should be entirely mediated by these motivational constructs. That is, a more positive affective response to exercise would influence exercise indirectly by increasing motivation to exercise. Evidence shows that a positive affective response to exercise is subsequently associated with increased exercise self-efficacy, and self-efficacy subsequently predicts exercise maintenance (e.g., McAuley, Jerome, Elavsky, Marquez, & Ramsey, 2003). This area of research has generally been limited to the relationship between affective response to exercise and self-efficacy, to the exclusion of other social cognitive constructs. We were interested in a more complete and theory-based characterization of motivation, and thus explored the degree to which affective response to exercise would predict, prospectively, attitudes, subjective norms and intentions, in addition to self-efficacy.

We have shown that one way the affective response is potentially related to behavior is that it moderates, and specifically strengthens, the relationship between intentions and behavior (Kwan & Bryan, in press). In that analysis from this dataset, those who experienced a more positive affective response to exercise were more likely to translate intentions into subsequent behavior. Conner, Sheeran, Norman, and Armitage (2000) suggest that factors that moderate the intention-behavior relationship do so via helping to maintain the temporal stability of intentions. As discussed above, intentions represent an individual's overall motivation to perform the behavior. Temporally unstable intentions might therefore reflect changes over time in an individual's motivation to exercise. If the affective response to exercise is an antecedent of motivation to exercise, then a more favorable affective response to exercise could correspond to more stable intentions to exercise. We might expect, then, that affective response to exercise not only influences levels of exercise-relevant motivational constructs, but helps to *sustain* motivation to exercise over time by encouraging more stable intentions.

This analysis focuses on identifying *mechanisms* by which the affective response to exercise promotes more frequent exercise behavior. The purpose of this analysis was therefore to show that those who experience a more positive affective response to exercise would report greater motivation to exercise at follow-up, in terms of TPB motivational constructs (self-efficacy, attitudes, subjective norms and intentions). While associations between these motivational constructs and affect are almost certain to be bi-directional and many studies have demonstrated the cognition to affect relationship (i.e., those with greater self-efficacy are more likely to report more positive exercise-related affect, Ekkekakis & Petruzzello, 1999), we aim to show evidence for the affect to cognition relationship. In other words, a goal of this study is to demonstrate that affective response is also *predictive* of motivation to exercise. In this study, affective response to exercise is measured three months prior to, and thus has temporal precedence over, measures of exercise motivation, providing evidence of the hypothesized direction of the relationship. We also hypothesize that positive affective responses would be associated with more temporally stable intentions. Participants completed baseline and follow-up measures of exercise self-efficacy, attitudes, subjective norms and intentions to exercise in the next 3 months. Participants also reported affective response to exercise during a 30-minute bout of moderate intensity treadmill exercise at baseline.

Method

Participants

The sample consisted of 129 healthy adults (67 women, 62 men) recruited from the local community (Table 1). Our objective was to recruit healthy participants who would not be at risk for negative cardiopulmonary events due to exercise, whose affective response would not be affected by psychological disorder or treatment, and who were neither completely sedentary nor elite athletes. Thus, eligible participants were between the ages of 18 and 35, non-smokers, not currently pregnant and having regular menstrual cycles, not on a restricted diet, not on psychotropic medications, not under treatment for any psychiatric disorder, not diabetic, no history of cardiovascular or respiratory disease, no flu or illness in the previous 3 months, a body mass index in the range of 18-29, and physically capable of engaging in moderate exercise.

Measures

Exercise behavior—Typical frequency of exercise was assessed with three questions specifically targeting voluntary aerobic exercise in the past three months (Bryan et al., 2007;

Kwan & Bryan, in press). Participants read a definition of aerobic exercise ("Any activity that uses large muscle groups, is done for at least 20 minutes each time, and is done at a level that causes your breathing to be heavy and your heart to beat faster (examples are running, swimming, bicycling, step aerobics, basketball)"). They then reported, 1) How often they engaged in aerobic exercise in the past three months (scale from 1 "Never" to 7 "Often"); 2) The average number of days per week they engaged in aerobic exercise in the past three months (0 to 7 days per week on average); and, 3) How many days they engaged in aerobic exercise in the past week (0 to 7 days; $\alpha = .86$). An index of voluntary exercise frequency was created by standardizing each of these items and calculating the mean. This measure of voluntary exercise behavior has been shown to be highly correlated with estimates of vigorous intensity exercise behavior obtained using the Physical Activity Recall (PAR) method, which is more objective and less prone to recall bias but is limited to the assessment of physical activity during only a single week (Kwan & Bryan, in press).

Attitudes—Attitudes towards exercise were assessed with five items, based on the most common behavioral beliefs listed by our study samples in elicitation studies: 1) Aerobic exercise would make me feel good about myself; 2) Doing aerobic exercise would make me feel like I never have any energy (reverse coded); 3) Engaging in aerobic exercise would keep me healthy; 4) Aerobic exercise would make me look worse physically (reverse coded); and 5) Aerobic exercise would make me appear more sexually attractive. Responses were made on a scale from 1 "Disagree strongly" to 7 "Agree strongly", and the mean of these items represented attitudes ($\alpha = .64$). In responding to these questions, participants were told to refer to the definition of aerobic exercise provided in the section on exercise behavior, for this and other TPB constructs.

Exercise self-efficacy—Participants were asked to rate their confidence regarding exercising under various circumstances on a scale from 1 "Disagree strongly" to 7 "Agree strongly". A single item assessed confidence in ability to exercise regularly, "I feel confident that I could do aerobic exercise for at least 20 minutes three times a week." Two items assessed confidence in ability to physically perform aerobic exercise, "I feel confident that I know how to do aerobic exercise correctly" and "I feel confident that I could do many different kinds of aerobic exercise." Four items assessed confidence in ability to do aerobic exercise when very busy, when feeling tired, when none of their friends would do it with them, and when feeling bored with it. These items are consistent with control beliefs listed by our study samples in elicitation studies, and have shown predictive validity in prior work (e.g., Bryan & Rocheleau, 2002). The mean of these items was calculated for a measure of self-efficacy ($\alpha = .83$).

Subjective norms—Subjective norms were assessed using five items regarding the degree to which participants felt that their friends, family members, significant others and health professionals thought they should engage in aerobic exercise (e.g., Most people who are important to me think I should do aerobic exercise). Participants indicated their agreement on a scale from 1 (Disagree strongly) to 7 (Agree strongly). The mean of these items was calculated for a measure of subjective norms ($\alpha = .85$).

Exercise intentions—Intentions to exercise were assessed with four items: 1) How likely is it that you will talk to your friends about aerobic exercise in the next three months?, 2) How likely is it that you will get or buy equipment that can be used for aerobic exercise (workout clothes, special shoes) in the next three months?, 3) How likely is it that you will go to a recreation center or a health club to do aerobic exercise in the next three months?, 4) How likely is it that you will actually do aerobic exercise for at least three times a week in the next three months?, on a scale from 1 (Not at all likely), to 7 (Very likely). The mean of these items was calculated to represent intentions ($\alpha = .69$). This measure has exhibited high reliability and predictive validity in previous work (Bryan & Rocheleau, 2002; Bryan et al., 2007), and adequate reliability in this study.

Temporal stability of intentions was calculated using a summary measure of four indices: the sum of absolute differences between each intention item at baseline and follow-up, the average absolute difference adjusted for maximal possible change, the absolute difference between the sum of intention items at baseline and follow-up, and the number of scale items that changed between baseline and follow-up (as instructed by Conner et al., 2000; See Campbell, 1990, for further information regarding these calculations). The mean of these standardized indices was calculated for each participant and then subtracted from 0 to represent temporal stability of intentions. Higher numbers on this index indicate more stable intentions over time.

Affect—The Physical Activity Affect Scale (PAAS; Lox, Jackson, Tuholski, Wasley, & Treasure, 2000) was used to assess affective response to exercise. The 12-item PAAS has four subscales: positive affect (‘enthusiastic’, ‘energetic’, and ‘upbeat’; $\alpha = .94$), negative affect (‘miserable’, ‘discouraged’, and ‘crummy’; $\alpha = .86$), tranquility (‘calm’, ‘relaxed’, and ‘peaceful’; $\alpha = .84$) and fatigue (‘fatigued’, ‘tired’, and ‘worn-out’; $\alpha = .91$). Participants rated their current affective state for each item on a scale from 0 (‘do not feel’) to 4 (‘feel very strongly’).[1]

Proceduce

Participants were recruited via posters displayed around campus, including the exercise facility, and in local businesses. Interested individuals called the study phone number, and research assistants explained the study and completed eligibility assessments. Most of those who called were eligible, and the few who were not were elite athletes or were unable to commit the time requested. Those eligible were scheduled at the university's General Clinical Research Center (GCRC). All procedures were approved by our university's internal review board and Scientific Advisory Committee of the GCRC. Participants received up to US$50 as an incentive for successful completion of all parts of the study. At the first session, participants gave informed consent, completed a baseline questionnaire, and engaged in a treadmill test of their maximal aerobic capacity (VO_2 max). Participants were asked to wear exercise attire and shoes, to eat and drink normally, and to refrain from consuming alcohol during the 24 hours prior to testing.

VO_2max was assessed via online computer-assisted open-circuit spirometry during incremental treadmill exercise on a motorized treadmill (Trackmaster 425 treadmill, Newton, KS; Christou, Gentile, DeSouza, Seals, & Gates, 2005). Each participant engaged in a 6- to 10- minute warm-up period to determine a starting speed that corresponded to 70% to 80% of age-predicted maximal heart rate, assessed using a 12-lead EKG (Pulmonary Exercise System, St. Paul, MN). They then ran or walked at this speed, with the treadmill grade increasing by 2.5% (or 2.0% at $\leq$ 6.0mph) every 2 minutes until volitional exhaustion. For a valid VO_2 max test, each participant had to meet at least three of the following four criteria: (1) plateau in VO_2 with increasing exercise intensity, (2) a maximal respiratory exchange ratio of $\geq$ 1.10, (3) achievement of age-predicted maximal heart rate (±10 bpm), and (4) a RPE of $\geq$ 18 on the

[1]In using this scale, we acknowledge the arguments against the use of distinct affective states and measures of affect developed to be “exercise-specific” because they are not all-inclusive or sufficiently broad to encompass the full affective experience of exercise across multiple populations and are not based on strong theory (Ekkekakis & Petruzzello, 2000). The current trend in the measurement of affective response to exercise is the use of single-item scales assessing valence (How good or bad do you feel?; Feeling Scale, Hardy & Rejeski, 1989) and activation (How much arousal do you feel?); Felt Arousal Scale; Svebak & Murgatroyd, 1985) consistent with the circumplex model of affect (Russell, 1980). It has been shown that the PAAS subscales satisfactorily map onto the four quadrants of the circumplex model of affect (Kwan et al., 2008). Furthermore, single-item scales have by nature limited variability, which limits statistical power to detect an effect, and reports of “how good or bad” one feels are likely highly subjective and it is difficult to know the degree to which that report reflects basic affect versus general physical discomfort (which may or may not contribute to basic affect).

Borg (1985) scale. Oxygen levels were assessed using the MedGraphics Cardi02/CP system (St. Paul, MN).

Participants returned to the GCRC for a submaximal exercise session about one week later. Participants reported pre-exercise values for the PAAS. They then warmed up on the treadmill until they achieved 65% of VO_2 max, which (at the time) was consistent with the American College of Sports Medicine's definition of moderate intensity exercise (ACSM, 2000). Once participants achieved 65% VO_2 max (a warm-up period of 3 to 7 minutes), they maintained this level of exertion for 30 minutes. Maintenance of 65% of VO_2 max during the course of the exercise bout was confirmed by both continuous heart rate and intermittent VO_2 assessment using a mouthpiece. After confirming 65% VO_2 max, the mouthpiece was removed. Heart rate was measured using a Polar S610 heart rate monitor.

The PAAS was administered at four time points during exercise – 5 minutes, 10 minutes, 20 minutes, and immediately prior to completion of the 30-minute bout of exercise. These time points were chosen so that we could assess changes early in exercise as well as at multiple other time points during exercise so that nonlinear trends could be analyzed. Because of the necessarily non-standard warm-up period, these time points should not be considered strict indicators of the time course of exercise. Following exercise, participants were allowed a 5-minute cool down and then sat quietly on a chair for 30 minutes, during which time their vital signs were monitored. The PAAS was also administered at fifteen and thirty minutes post-exercise. When controlling for baseline affect, the in-task and post-task affective responses were highly correlated (r's > .60) and the results were not substantially different when considering in-task vs. post-task influences. The findings presented are therefore primarily limited to the in-task PAAS measures, as these effects were typically stronger than and in the same direction as post-task affect. Three months later, participants completed a follow-up questionnaire, re-assessing motivational constructs and exercise behavior.

Results

Univariate Analyses

The sample size for this analysis is 127 (98.4% follow-up rate). Means, standard deviations and correlations for primary study variables are shown in Table 2. Examinations of skew and kurtosis revealed no problematic deviations from normality or homoscedasticity, except for measures of negative affect. A minority of participants reported non-zero values on negative affect items at any point, indicative of floor effects. As such, there were no statistical transformations appropriate for this variable, and results are presented for untransformed values and should be interpreted with this in mind.

Changes in affect during exercise

Random coefficient regression was used to model within-subject linear and quadratic changes in affect over the five time points during exercise (SAS Version 9.0). Positive affect showed a significant positive linear effect of time, $\beta = .52$, $SE = .09$, $p < .0001$, qualified by a quadratic effect of time, $\beta = -.09$, $SE = .027$, $p = .001$. Negative affect showed a significant negative linear effect of time, $\beta = -.12$, $SE = .04$, $p = .005$, qualified by a quadratic effect of time, $\beta = .03$, $SE = .01$, $p = .008$. Tranquility also showed a negative significant linear effect of time, $\beta = -.62$, $SE = .09$, $p < .001$, qualified by a quadratic effect of time, $\beta = .26$, $SE = .03$, $p < .001$. Finally, fatigue showed a significant negative linear effect of time, $\beta = -.39$, $SE = .09$, $p < .001$, qualified by a quadratic effect of time, $\beta = .12$, $SE = .02$, $p < .001$. Participants on average reported gradual increases in positive affect and gradual decreases Cin negative affect, tranquility and fatigue over time, and these effects tapered off as exercise progressed.

Changes in affect post-exercise

On average, positive affect increased between baseline and 15-minutes post-exercise, $\beta = .73$, $CI_{.95} = .56, .89$, $t(126) = 8.63$, $p < .0001$. Negative affect decreased between baseline and 15-minutes post-exercise, $\beta = -.13$, $CI_{.95} = -.21, -.05$, $t(126) = -3.20$, $p = .002$. Tranquility increased between baseline and 15-minutes post-exercise, $\beta = .63$, $CI_{.95} = .47, .79$, $t(126) = 7.27$, $p < .0001$. Fatigue decreased between baseline and 15-minutes post-exercise, $\beta = -.21$, $CI_{.95} = -.37, -.05$, $t(126) = -2.62$, $p = .01$. Partial correlations between in-task and post-task affect (controlling for baseline affect) are shown in Table 2.

Affective response to exercise and motivation to exercise at follow-up

Within-subject linear slopes for affective response to exercise were calculated for each participant using individual regression analyses. We then used these slopes as predictors of motivation. Our intention was to consider an affective *response* to exercise, and slopes represent a response in terms of change over time. Partial correlations between in-task linear slopes, and attitudes, self-efficacy, subjective norms and intentions at follow-up, controlling for baseline affect, are shown in Table 2. The linear slopes for positive affect were positively associated with attitudes, self-efficacy, and intentions, while the negative affect slopes and fatigue slopes were negatively associated with these constructs at follow-up. The linear slopes for tranquility did not predict attitudes, self-efficacy or intentions. None of the affect slopes predicted norms. As the linear trends were qualified by quadratic trends, we also conducted these analyses using the linear and quadratic slopes calculated from the quadratic model. Results were not substantially different in this case. Due to problems with multicollinearity and difficulty with interpretation, we determined the initial analysis was preferred.

Next we examined the relationship between affect at 15-minutes post-exercise (results were comparable for the 30-minute values) and motivation to exercise at follow-up (Table 2). These results are not substantially different from the effects of in-task affect, and were typically weaker. An exception is the effect of post-task tranquility, which did have small positive effects on attitudes and self-efficacy, which were not evident for in-task affect.

Path models

Path models were tested in AMOS Version 16.0. We first modeled the TPB to ensure it was a good fit in this sample ($\chi^2(2, N = 127) = 1.11$, $p = .57$, $RMSEA = .000$, 90% CI: .000, .149). As expected, self-efficacy, attitudes and subjective norms were positively associated with intentions to exercise, which were then positively associated with frequency of participation in exercise reported at follow-up. To examine whether the effects of changes in affect in response to an exercise bout (i.e., affect slopes) on intentions were mediated by attitudes, norms and self-efficacy, one path model for each PAAS subscale was estimated (see Figure 1a-1d). Each model specified a path between affect (baseline and slopes) and attitudes, norms and self-efficacy, and between these TPB constructs and intentions. For positive affect only, modification indices suggested there should be a direct path from baseline affect to intentions; this path was therefore specified as well. These models all fit the data very well. In all models, attitudes, norms, and self-efficacy were, as would be expected by theory, significantly related to intentions. For positive affect, both the slope and baseline positive affect were significantly related to attitudes and self-efficacy, but only baseline positive affect was associated with norms. The slope, but not baseline levels, of fatigue was negatively associated with attitudes and self-efficacy. Neither the slope nor baseline fatigue predicted norms. Both the slope and baseline levels of negative affect were negatively related to attitudes and self-efficacy, but not with norms. Finally, baseline levels of tranquility were significantly positively related to self-efficacy and marginally related to attitudes. Slopes for tranquility did not predict self-efficacy or attitudes, and neither slopes nor baseline tranquility predicted norms.

Next we tested the hypothesis that attitudes, norms and self-efficacy mediate the relationship between affective response and intentions using tests of direct and indirect effects in AMOS. To do this, we utilized standardized estimates and indirect, direct and total effects with bootstrapping on 2000 samples and bias-corrected confidence intervals (90%). The two-tailed significance for the confidence intervals provides a test of the standardized estimates for the indirect, direct and total effects. There were significant indirect effects ($p < .01$) of both the slope for positive affect and baseline positive affect on intentions, suggesting that relationship between positive affect and intentions was significantly mediated by attitudes, norms and self-eficacy. However, there was also a remaining significant deirect effect ($p < .05$) of the baseline positive affect on intentions, indicative of only partial mediation for that variable. Fore negative affect, both the slop ($p < .01$) and beseline negative affect ($p < .05$) had significant indirect effects on intentions, with no significant direct effects, indicative of full mediation. There was a significant indirect effect of the slope for fatigue, but not baseline fatigue, on intentions ($p < .01$), with no remaining direct effect. For tranquility, there was a significant indirect effect of baseline tranquility, but not the slope, on intentions ($p = .01$), and no direct effects. In sum, the weight of the evidence indicates that the influence of affective change in response to exercise on intentions to exercise is mediated through TPB motivational constructs.

The results were not substantially different when path models were estimated using the post-task affect measures, and are therefore not shown.

Temporal stability of intentions

Temporal stability of intentions from baseline to three months was associated with more frequent participation in exercise over the course of the intervening three months, $\beta = .39$, $SE = .08$, $\eta^2 = .17$, $F(1,125) = 24.70$, $p < .001$. There was a significant interaction between temporal stability of intentions and intentions to exercise, $\beta = .22$, $SE = .07$, Partial $\eta^2 = .08$, $F(1,123) = 10.43$, $p < .001$, such that more stable intentions strengthened the relationship between intentions and behavior. Similarly, there was a significant interaction between baseline exercise frequency and temporal stability of intentions, $\beta = .21$, $SE = .08$, Partial $\eta^2 = .05$, $F(1,123) = 6.86$, $p = .01$, such that past behavior was a better predictor of future behavior when intentions were more stable. This is consistent with previous studies that show temporal stability of intentions is an important factor in translating intentions into behavior and maintaining exercise over time.

We then hypothesized that the in-task affective response to exercise would influence temporal stability of intentions. As expected, controlling for baseline positive affect, those who experienced steeper improvements in positive affect during exercise had more stable intentions over time, $\beta = .93$, $SE = .10$, Partial $\eta^2 = .07$, $F(1,124) = 8.82$, $p = .004$. Furthermore, controlling for baseline fatigue, those who experienced less steep increases in fatigue during exercise also had more stable intentions over time, $\beta = -1.32$, $SE = .11$, Partial $\eta^2 = .12$, $F(1,124) = 17.64$, $p < .0001$. Together, baseline values for all four affect measures and within-subject slopes for all four affect measures explained 31 percent of the variance in temporal stability of intentions, with 16 percent due to baseline affect alone. These effects were highly comparable when using post-task rather than in-task affect, such that again only positive affect and fatigue at 15-minutes post-exercise predicted temporal stability of intentions.

Summary of findings

Those with a more positive affective response to exercise (greater positive affect, less negative affect and fatigue) reported more favorable attitudes, self-efficacy and intentions to exercise at follow-up. In contrast, norms were generally unrelated to affective response. The effects of affective response on intentions were largely indirect effects mediated by attitudes and self-efficacy. Furthermore, those who experienced greater increases in positive affect and decreases in fatigue during exercise had more temporally stable intentions to exercise, and temporally stable intentions were associated with higher levels of voluntary exercise participation. These effects were typically stronger for in-task than post-task affect.

Discussion

Our results suggest that a positive affective response to exercise is prospectively associated with greater motivation to exercise, and also aids in sustaining motivation over time. Those who responded more favorably to an acute bout of exercise at baseline had greater self-efficacy, more positive attitudes and more positive intentions, but no more positive subjective norms, at follow-up. We also found that, as predicted, a positive affective response to exercise was associated with more temporally stable intentions, and that more stable intentions strengthened the relationship between intentions and behavior and the relationship between past behavior and future behavior. This suggests that a positive affect response to exercise is not only associated with greater motivation to exercise, but also more stable motivation to exercise. This then corresponded with better exercise maintenance, such that the relationship between past behavior and future behavior was stronger when intentions were temporally stable. That affective response was not associated with subjective norms is an important, if not unexpected, finding. It specifically shows that a positive affective response to exercise does not simply result in a halo effect, in which all evaluations of exercise-related concepts are more favorable.

We also considered possible differences in the effects of in-task vs. post-task affective response to exercise on motivation to exercise. With the exception of tranquility (how relaxed and calm someone felt after exercise), the in-task affective response typically had stronger influences on motivation to exercise at follow-up than did post-task affect. We can speculate that this is because the in-task response is more associated with how it feels to engage in exercise itself, while the post-task response is associated with how it feels to be done with exercise (e.g., relieved). It stands to reason that those who feel good (and increasingly so) *while* exercising will report being more motivated to exercise than those who are just happy to be finished exercising.

Previous research has shown that affective response to exercise is correlated with exercise motivation and goals, typically in support of the idea that those with, for example, greater self-efficacy would have more positive evaluations of exercise-induced feeling states (Ekkekakis & Petruzzello, 1999). In his dual-mode hypothesis of the determinants of the affective response to exercise, Ekkekakis (2003) explicitly states that cognitive appraisals such as self-efficacy influence affective response, especially at moderate intensity. Evidence supports this hypothesis (Bodin & Martinsen, 2004; Bozoian, Rejeski, & McAuley, 1994; Focht et al., 2007; McAuley, Blissmer, Katula, & Duncan, 2000). For instance, Lochbaum and Lutz (2005) showed that people who have higher scores on the various subscales (e.g., value/self-efficacy, self-monitoring, social comparison) of the Goal Systems Assessment Battery (Karoly & Ruehlman, 1995) tended to subsequently report more positive affective response to exercise and greater exercise enjoyment. Jerome and colleagues (2002) manipulated exercise self-efficacy in a laboratory setting via false feedback. This manipulation subsequently predicted affective response to a 20-minute bout of moderate-to-vigorous intensity treadmill exercise.

Similarly, measures of motivation based on Self-Determination Theory (SDT; Ryan & Deci, 2000) also predict affective response to exercise. Lutz, Lochbaum, and Turnbow (2003) found that an SDT-based measure of motivation to exercise predicted affective response to exercise, such that those who reported more self-determined motivation to exercise reported significantly greater positive affect and marginally greater energetic arousal following a moderate-intensity aerobics session. An SDT-based exercise intervention in which an aerobics class was taught in an autonomy-supportive style vs. usual teaching style was shown to yield more positive affective responses to exercise over the course of 10-week class (Edmunds, Ntoumanis, & Duda, 2008). Thus, those who engage in exercise for more self-determined reasons tend to have a more pleasant affective experience when exercising. Related evidence shows that affective response to exercise is more positive when people are allowed to self-select the mode (Daley & Maynard, 2003; Miller, Bartholomew, & Springer, 2005) and intensity (e.g., Ekkekakis & Lind, 2006; Parfitt, Rose, & Burgess, 2006; Szabo, 2003) of exercise. A core feature of self-determined motivation is a sense of autonomy, and giving participants a choice of exercise when assessing affective response to exercise may essentially be a manipulation of self-determined motivation.

Thus there is certainly convincing evidence that affective response to exercise can be influenced by motivational constructs such as self-efficacy and self-determination. Our findings provide additional, prospective evidence that the relationship is quite possibly bi-directional and reciprocal (operates in a feedback loop), and that affective response can influence (and possibly reinforce) subsequent motivation in terms of self-efficacy, attitudes and intentions. In particular, our results suggest that a positive affective response to exercise influences the degree to which motivation to exercise stays positive over time, and thus could be a particularly important predictor of exercise maintenance over the long term. The direction of the effect (motivation to affect, affect to motivation, or both) has not been clearly identified, and this paper cannot make strong causal inference. This is especially true given that the observed effects were substantially reduced (although still evident) when controlling for baseline values for attitudes, self-efficacy, and intentions (data not shown). However, we did not expect changes in these variables over time, as there was no intervention and this population was already active at baseline. Including both baseline and subsequent assessments in the same model essentially amounts to a test-retest reliability of the measure, rather than true predictive relationships.

It stands to reason that the affective response to exercise serves as reward and punishment in learning (see also Simon, 1967), and as a result contributes to the construction (and reconstruction) of cognitive representations of beliefs about exercise, such as attitudes and self-efficacy. Future research might focus on manipulating affective response (preferably in a population that does not have considerable recent past experience with exercise) and measuring motivation to exercise post-task to determine if in fact there is strong causal evidence for this directional relationship. What cannot be ignored, however, is that the hypothesis that the relationship between affective response to exercise and participation in exercise is due to differences in motivation (as operationalized by the TPB) may not be a sufficient explanation of the mechanism. That the affective response moderates the intention-behavior relationship (Kwan & Bryan, in press) and predicts temporal stability of intentions (but not absolute change) suggests that the affective response plays a role in the volitional phase of behavior change – in which intentions are translated into action.

Another important consideration here is the degree to which affective response to exercise is already reflected in affective attitudes towards exercise – beliefs about the degree to which exercise is, for example, pleasurable, satisfying and rewarding. Our measure of attitudes was perhaps more representative of instrumental attitudes – beliefs about the degree to which exercise has positive outcomes such as positive self-esteem and physical attractiveness. Recent research has shown that a multi-component version of the TPB that considers both affective and instrumental attitudes explains more variance in intentions than a more general measure of attitudes (e.g., Rhodes, Blanchard, & Matheson, 2006). Our results cannot distinguish between the actual affective experience of engaging in aerobic exercise and subsequent affective attitudes towards exercise, and cannot speak to how they may have similar effects on exercise motivation and behavior. This may be an important question to address in the future. As people tend to be poor at remembering past emotions and forecasting future emotions

(Wilson & Gilbert, 2003), we suspect that actual experienced affect and affective attitudes (to the extent that they represent anticipated and/or previously experienced affect) are distinct.

Limitations

Our sample represented young, healthy, fit and active individuals with positive intentions to exercise at baseline. The results therefore do not necessarily speak to adoption of exercise as much as maintenance, and may not generalize to other populations of interest (e.g., sedentary individuals, elderly individuals). Another issue is our implicit assumption that the affective response to exercise in the laboratory setting is prototypical and representative of a participant's real world affective response to exercise, which evidence suggests is not necessarily unrealistic (Kerr, Fujiyama, Sugano, Okamura, Chang, & Onouha 2006). However, given that the affective response to one's chosen exercise type, intensity, and duration is likely to be stronger than that of an artificial setting suggests that if anything our controlled laboratory approach underestimates the importance of affective response to exercise in motivation to exercise.

Another limitation is the measurement of TPB constructs in this study. Despite the fact that the measurement of exercise attitudes was consistent with results of elicitation studies conducted in this population and has been used in prior work (Bryan & Rocheleau, 2002), reliability of this measure was only fair. One reason for the lack of internal consistency in this scale may relate to the distinction between affective and instrumental attitudes (Rhodes et al., 2006). Several of our items were consistent with instrumental attitudes (e.g., exercise will make me healthy) while others were more consistent with affective attitudes (e.g., exercise would make me feel like I have no energy). Finally, the self-report nature of exercise behavior in this study is also a limitation.

Practical Implications

The results of this study may aid in the design of more effective exercise interventions, especially with respect to encouraging more stable intentions to exercise and greater behavior maintenance. An intervention that aims to improve the affective response to exercise for those who do not naturally respond positively may be particularly successful. To do this, we need a better understanding of the determinants of the affective response to exercise and the factors that modify it. This will likely require a transdisciplinary approach, including consideration of genetic, physiological and social/cognitive variables (Bryan et al., 2007; Ekkekakis, 2003) and environmental variables (Kerr et al., 2006).

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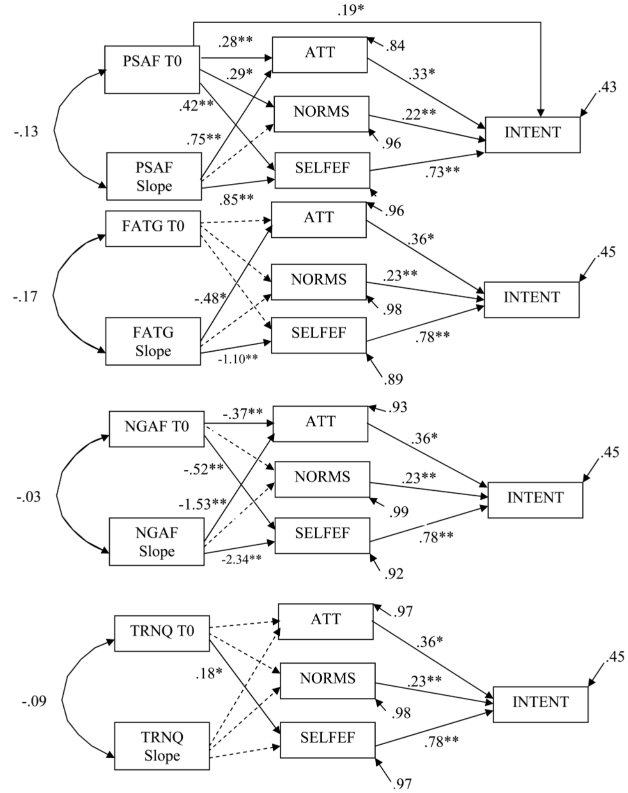

Figure 1.

Path models of the relationships between in-task affect and motivation at follow-up. 1a: Positive Affect (PSAF), $\chi^2(1) = .19$, p = .66, CFI = 1.00, RMSEA = .00 (.00, .18); 1b: Fatigue (FATG), $\chi^2(2) = 1.12$, p = .57, CFI = 1.00, RMSEA = .00 (.00, .15); 1c: Negative Affect (NGAF), $\chi^2(2) = 1.86$, p = .40, CFI = 1.00, RMSEA = .00 (.00, .17); 1d: Tranquility (TRNQ), $\chi^2(2) = 1.62$, p = .45, CFI = 1.00, RMSEA = .00 (.00, .17). Affect at T0: Baseline affect. ATT: Attitudes; SELFEF: Self-Efficacy; NORMS: Subjective Norms; INTENT: Intentions. Covariances between attitudes, self-efficacy and norms were estimated (all were positive and significant) but not shown for clarity of presentation. Paths estimated but not significant are shown as dashed lines.

*$p < .05$, **$p < .01$

Unstandardized regression coefficients are shown.

Table 1

Sample characteristics

	Full Sample (N = 129)	**Men (n = 62)**	**Women (n = 67)**
Age: Mean (*SD*)	22.40 (*4.15*)	22.60 (*4.22*)	22.22 (*4.12*)
Race: N (%) White	102 (79.69)	51 (82.26)	51 (77.27)
VO_2max: Mean (*SD*)	47.51 (*7.42*)	52.04 (*6.60*)	43.45 (*5.55*)**
Exercise at baseline: Mean days/week last 3 months (*SD*)	3.83 (*1.69*)	3.65 (*1.86*)	4.00 (*1.52*)
Exercise at follow-up: Mean days/week last 3 months (*SD*)	3.60 (*1.79*)	3.61 (*1.95*)	3.60 (*1.63*)

** Significant gender difference, $p < .0001$

Table 2

Means, standard deviations and partial correlations for affective response to exercise and motivational constructs at follow-up

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1) PSAFL	.57	1.06	1.00										
2) NGAFL	−.14	.49	−.18*	1.00									
3) TRNQL	−.62	1.08	.18*	−.11	1.00								
4) FATL	−.42	.99	−.55***	.40***	.04	1.00							
5) PSAF15	2.37	.95	.68***	−.14	.23*	−.27**	1.00						
6) NGAF15	.11	.33	−.12	.65***	−.06	.33***	−.21*	1.00					
7) TRNQ15	2.91	.85	.18*	−.10	.61***	−.01	.34***	−.25**	1.00				
8) FAT15	3.33	.88	−.38***	.24**	.05	.72***	−.37***	.37***	−.12	1.00			
9) Attitudes	6.34	.60	.33***	−.23**	.12	−.20*	.24**	−.11	.18*	−.21*	1.00		
10) Self-Efficacy	6.00	.87	.26**	−.24**	.05	−.32***	.21*	−.22*	.16	−.36***	.51***	1.00	
11) Norms	5.07	1.17	.11	−.07	.11	−.12	.10	.01	.13	−.14	.29**	.28**	1.00
12) Intentions	5.91	1.25	.19*	−.12	.08	−.23**	.11	−.07	.08	−.23**	.51***	.69***	.42***

Partial correlations are shown for relationships between in-task and post-task affect and motivational constructs at follow-up, controlling for relevant baseline affect. PSAFL = positive affect, linear slope, NGAFL = negative affect, linear slope, TRNQL = tranquility, linear slope, FATL = fatigue, linear slope. PSAF15 = positive affect, 15 minutes post-exercise, NGAF15 = negative affect, 15 minutes post-exercise, TRNQ15 = tranquility, 15 minutes post-exercise, FAT15 = fatigue, 15 minutes post-exercise.

*** $p \leq .001$

** $p \leq .01$

* $p \leq .05$