Exercise and Affect

There is growing literature demonstrating that exercise is associated with greater well-being, especially among women (Brown, Gilson, Burton, & Brown, 2011; Lotan, Merrick, & Carmeli, 2005; Penedo & Dahn, 2005). In particular, there is promising evidence regarding the positive influence of exercise and physical activity on several indicators of well-being including affect (Berger & Motl, 2000; Biddle & Mutrie, 2008). Greater levels of positive affect have been identified as a hallmark quality of well-being (Russell, 2003). More specifically, repeated satisfying exposure to short-term positive affect states, such as those achievable with acute bouts of exercise, can lead to increased well-being (Lyubomirsky, King, & Diener, 2005; Rousseau & Vallerand, 2008).

Affect reflects the quality of a subjective feeling state and Lazarus (2000) describes emotions (or affect) as motivational, thus, involving reactions to adaptational goals in a person’s life. Affect can be characterized by two dimensions, namely, valence (positive/negative) and activation (high activation [HA]/low activation [LA]; Ekkekakis & Petruzzello, 2002). Whereas HA affect refers to an energetic state and excitation, LA affect refers to a calm, relaxed or depressed state. A dimensional definition facilitates the detection and comparison of broader changes in affect in a breadth of behavioral domains, such as exercise (Ekkekakis & Petruzzello, 2002).

Meta-analytic evidence indicates that acute exercise has a moderate, consistent effect on levels of positive affect (Reed & Ones, 2006). Although underexamined as an influential factor in regular exercise engagement, repeated, positive affective experiences associated with individual (acute) exercise sessions may sustain motivation over time and this can facilitate long-term exercise participation (Focht, 2009; Kwan & Bryan, 2010). Indeed, according to Self-Determination Theory (SDT) motivation and affective indicators of well-being are intricately connected (Deci & Ryan, 1985, 2002). It is relevant then that the link between exercise and affect may be particularly evident in active, motivated individuals who are experienced with exercise (Hoffman & Hoffman, 2008; Markowitz & Arent, 2010). As some authors...
have revealed, it can be informative to study an active population because much can be learned regarding the determinants of successful exercise engagement and associated consequences, which could then be targeted among the insufficiently active (Duncan, Hall, Wilson, & Jenny, 2010).

Likewise, the relationship between exercise and well-being, especially affect, seems to be quite pronounced in women (Gill, Williams, Williams, Butki, & Young, 1997; Kull, 2002). Studies with women consistently demonstrate the positive influence of exercise on affective states immediately afterward (Cramp & Bray, 2010; Gauvin, Rejeski, & Rebossin, 2000). Improvements in overall positive affect among women have also been noted, as have improvements in feelings of vitality (Kelsey et al., 2006; Wendel-Vos, Schuit, Tijhuis, & Kromhout, 2004). Despite the emotional benefits, women engage in lower levels of physical activity than men, which may be related to psychological variables that are uniquely associated with women’s engagement in exercise (Bassett, Wyatt, Thompson, Peters, & Hill, 2010; Colley et al., 2011; Segar, Jayaratne, Hanlon, & Richardson, 2002). The SDT framework is one psychological perspective that has been strongly advocated to explain women’s engagement in exercise, including affective experiences, and this backing is consistent with broader calls in the literature for more women-focused research looking at exercise (Ainsworth, 2000; Landry & Solmon, 2002). On a more global scale, women’s mental health, which encompasses their affective states, deserves attention in its own right as it generally tends to be poorer than that of men (Denton, Prus, & Walters, 2004).

### Explaining the Exercise–Affect Relationship

Although the evidence to date is convincing, the relationship between exercise and well-being is far from simplistic, especially when it comes to predicting affect (Biddle & Ekkekakis, 2005). Indeed, variability across research findings is indicative that not all individuals who participate in exercise achieve greater well-being (O’Connor & Puetz, 2005). For instance, Van Landuyt, Ekkekakis, Hall, and Petruzzello (2000) found that only half of participants engaging in a 30-min moderate to high intensity cycling task felt progressively better. The implication of these and other findings such as Brown et al. (2004) is that merely engaging in exercise, in terms of amount and/or intensity, may be insufficient to accrue affective benefits. Indeed, there is a need for more sophisticated knowledge of underlying processes with which exercise may or may not benefit affective states (Berger & Motl, 2000; Biddle & Ekkekakis, 2005; Ekkekakis, Parfitt, & Petruzzello, 2011). Specifically, experts have called for more research on the moderators associated with different patterns of postexercise affect (Reed & Ones, 2006). Moderating variables can inform us of the circumstances under which a given association occurs.

Although exercise characteristics, such as type, intensity, and duration can modify its association with affect, the evidence remains inconsistent (Markowitz & Arent, 2010). In addition, a sizable proportion of earlier research on exercise stimulus factors has been atheoretical, prompting experts to recommend greater use of theoretical models (Berger & Motl, 2000; Reed & Buck, 2009). The use of theory allows researchers to conjure up explanations of how and why certain phenomena occur (or do not). Despite some conceptual progress, for example with “dual-mode theory” (Ekkekakis, 2003), physiological processes have been prioritized, whereas other theory-based variables of a psychological nature ought to be better accounted for (Berger & Motl, 2000; Ekkekakis et al. 2011; Reed & Ones, 2006). Among the theoretical, person-centered work that has emerged (e.g., self-efficacy), to the authors’ knowledge there is still a gap with respect to moderating motivational variables, as initially highlighted by Berger and Motl (2000; Raedeke, Focht, & Scales, 2009). Surely there is a need for more theory-based enquiries of motivation in this area given the central role of motivational variables in our understanding of exercise behavior and of indicators of well-being, such as positive affect (Biddle & Mutrie, 2008; Sebire, Standage, & Vansteenkiste, 2009). Examining motivation as one theory-based link may help explain conflicting evidence in this area.

### Self-Determined Motivation

Specifically, the quality of motivation, namely, one’s self-determination as purported by SDT, may supply a missing link in understanding well-being (in this case, affect)-related outcomes of exercise (Thegersen-Ntoumani & Fox, 2007). Moderation frameworks, using self-determined motivation have proven useful in explaining behavior–well-being relationships (Lemyre, Roberts, & Stray-Gundersen, 2007). According to the founders of SDT, the guiding theoretical framework for this study, motivation can be distinguished along a continuum from controlled (extrinsic) motivation, resulting from demands and/or pressure, to more autonomous or self-determined motivation, arising from elements of volition, choice, and interest (Deci & Ryan, 1985). The continuum is delineated as having six behavioral regulations that are increasingly more self-determined (Deci & Ryan, 2002). The influence of motivation is also thought to be hierarchically organized, whereby the regulations operate at three levels of generality: situational, contextual, and global (Vallerand, 2007). Whereas situational motivation refers to a state of motivation experienced at a specific point in time, contextual motivation is a more stable motivational orientation for the activity defined more broadly. Global motivation implies a person’s general orientation to interact with their environment at large (Vallerand, 2007). Within this hierarchy, the level of a given outcome (e.g., postexercise affect) should correspond to the motivation level that produced it (e.g., pre-exercise, situational).
Amotivation lies at one end of the continuum and represents the lack of intention to act and adjacent to it, external regulation is defined as being motivated according to external demands (e.g., to avoid punishment for not running; Deci & Ryan, 2002). Next, introjection involves a slight internalization, a process whereby regulation of a behavior is taken in and integrated with one’s sense of who they are. Still, there is little acceptance of it as one’s own because, for example, a woman may be following a running program due to sentiments of guilt or shame (e.g., physique-related; Deci & Ryan, 2002). Often, one feels pressure to engage in the activity to gain a sense of self-worth. Next on the spectrum is identified regulation; this is the first of the more self-determined motivation types as it arises when an individual values the behavior and assigns it personal importance (e.g., running for one’s health). Ensuing is integrated regulation, which involves engaging in an activity because it is well assimilated into one’s identity and core values (e.g., “I am a runner”). Measurement of the latter regulation has been much less common given that empirical distinctions between identified and integrated regulation have been slower to emerge. Last, at the other extremity of the continuum lies intrinsic motivation, as characterized by enjoyment and by inherent satisfaction in an activity, whereby an individual engages in the activity for its own sake (Deci & Ryan, 2002).

In SDT, it is posited that controlling forms of motivation (i.e., external, introjected) generally lead to less adaptive consequences than more autonomous motivation (i.e., intrinsic, identified). Studies have consistently shown that individuals who are more self-determined for exercise tend to not only engage in more physical activity (Sebire, Standage, & Vansteenkiste, 2011) but also report greater emotional benefits, such as elevated general positive affect (Puente & Anshel, 2010). Self-determined motivation (intrinsic motivation and identified regulation in particular) can also predict better self-evaluation patterns, which have been linked to positive affect and well-being (Brunet & Sabiston, 2009; Thogersen-Ntoumani & Ntoumanis, 2006). Among regular exercisers, intrinsic exercise motives have been tied to lower stress levels and better scores on global indicators of well-being (Maltby & Day, 2001).

Conversely and still in the exercise context, external regulation among women has been associated with unstable self-esteem and greater negative affect (Gagné, Ryan, & Bargmann, 2003). Moreover, introjected regulation for exercise has been linked to lower vitality and poorer life satisfaction (Edmunds, Ntoumanis, & Duda, 2007; Thogersen-Ntoumani & Fox, 2007). However, results are somewhat equivocal with introjection because this type of motivation has also been correlated with behavioral persistence (Sabiston et al., 2010; Stephan, Boiché, & Le Scanff, 2010). There is evidence that, for women, higher amounts of introjection can have a positive influence on intentions and exercise behavior itself (Markland, 2009; Thogersen-Ntoumani & Ntoumanis, 2006). This controlling regulation has also been associated with the intensity with which women exert themselves during exercise, which can impact their affect postexercise (Duncan et al., 2010; Guérin & Fortier, 2012). Indeed, women have been found to endorse greater levels of introjection than men (Wilson, Rodgers, Fraser, & Murray, 2004). In sum, the influence of introjection appears to be ambiguous. Although introjection can positively predict behavioral engagement (i.e., exercise), it may simultaneously compromise markers of well-being (i.e., affect), as purported by SDT (Teixeira, Carraca, Silva, & Ryan, 2012).

There are only a few studies that have examined the influence of self-determination on positive affect in the acute phase of exercise. Among them, Lutz, Lochbaum, and Turnbow (2003) found that higher self-determined contextual motivation toward exercise predicted greater positive affect after an exercise class. However, their research design did not allow for testing the specific moderating effect of self-determined motivation, including the motivational regulations as distinct predictors/moderators, and the authors focused on contextual motivation. Moreover, Lutz et al. used the convenience of an exercise class rather than an experimental design. Despite the advantage of naturalistic research for improved ecological validity, it offers less containment of confounding influences (e.g., social variables, distractions, etc.).

Also, there is evidence to support the suggestion that affective states produced or modified in controlled environments are not that different from those in nonlaboratory settings (Blanchard, Rodgers, & Gauvin, 2004). Experimental studies of exercise enable good control of extraneous influences, allowing for explorations of potential mechanisms as well as moderating processes/conditions. Therefore, the focus of the present investigation was on the moderating effect of motivation on the acute exercise-positive affect link in the context of an in-laboratory, running experiment. It would appear that this is the first study to pursue this. In keeping with expert advice that laboratory researchers should adequately match an exerciser’s usual exercise modality, we targeted self-reported runners (Kerr & Kuk, 2001). This was also prudent given evidence that exercise preference and familiarity can influence exercise-related mood changes (Lane, Jackson, & Terry, 2005). Likewise, a self-paced running task was deemed favorable as this was in line with SDT principles of optimizing choice as well as evidence, showing greater positive affective responses from self-paced exercise (Vazou-Ekkekakis & Ekkekakis, 2009).

**Aims and Hypotheses**

The purpose of this within-participant experiment was to examine the moderating influence of situational motivation (for running) on the relationship between an acute bout of preferred exercise (i.e., running vs. control) and pre-post changes in positive affect. This study was part of a larger
project. The results of a preliminary paper focusing solely on the running activity showed that introjected regulation interacted with the perceived intensity of the run to predict positive affect such that women with lower introjection saw improvements in positive affect as their ratings of perceived exertion (RPE) for the run increased (Guerin & Fortier, 2012). By comparing a running activity with a control task, the present enquiry expands on the previous report by testing the full moderating effect of motivational regulations individually. Several premises were tested.

First, a preliminary hypothesis was that participants would show a greater pre-to-post increase in positive affect when engaging in a running task compared with a control task (Blanchard et al., 2004; Reed & Ones, 2006). Second, based on SDT and the little research to date, it was expected that women with higher levels of intrinsic motivation and identified regulation would show strong increases in positive affect postrunning and not postcontrol (i.e., moderation effect; Edmunds et al., 2007; Lutz et al., 2003). In contrast, given prominent feelings of pressure/onus to run that seem incongruent with pleasant states, women with higher levels of external and introjected regulations would show a weak or no change in positive affect postrunning, similar to that achieved postcontrol (Deci & Ryan, 2002; Teixeira et al., 2012).

Given these speculations, a third and exploratory line of enquiry targeted the relative effects of motivational regulations on positive affect following the running task specifically. Based on SDT and previous findings (Lutz et al., 2003; Edmunds et al., 2007), it was expected that intrinsic and identified regulations would exert positive influences on postrun positive affect after controlling for prerun (baseline) levels of affect. These regulations would explain a greater amount of variance in postrun positive affect than introjected or external regulations, as these latter associations with postrun affect were expected to be weak or even slightly negative.

Method

Participants

Women between the ages of 25 and 55 years were recruited from local universities, chiropractic clinics, and sport/children stores via posters and word of mouth as well as through running/athletics websites. Eligible participants reported no underlying medical condition, were not currently pregnant, and satisfied a health screening test for exercise. All participants were active; that is, they reported a minimum of 20 min of moderate to vigorous exercise at least three times per week for at least 6 months. It was also required that participants perceive running as their preferred or most frequent exercise modality. These criteria were confirmed via self-report during each participant’s initial contact to participate in this study. The final sample size was 41, and this was deemed satisfactory to detect a medium-sized effect using repeated measures ANOVAs (GPower 3.1.2) and as established from previous studies (Reed & Ones, 2006). Although small for multiple regressions, these adjunct analyses served an exploratory purpose and no a priori power analysis was conducted. That said, similar sample sizes have been used in other repeated measures investigations in this area as well as other studies applying hierarchical regression with a similar number of variables (e.g., Berlin, Kop, & Deuster, 2006).

Measures

Demographic/background measures. A demographic form consisted of questions that were both general (e.g., occupation, height, weight) and running specific (e.g., I have been running at my current intensity/frequency for: [blank] months). Body Mass Index (BMI) was calculated as weight (in pounds) multiplied by 703 then divided by height (in inches) squared. The Godin Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985) was used to describe participants’ current exercise levels. Participants evaluated the number of days in a typical week they had engaged in light, moderate, and strenuous exercise. The frequency values were multiplied by their corresponding intensity value, namely 3, 5, and 9, and then summed to provide a total weekly activity score. All 41 women met a cut-off score of 24 to be included in the analyses, which is consistent with recommendations for health benefits and is equivalent to just over two vigorous and one moderate session per week (Grodin, 2011).

Affect. The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) was administered to measure pre- and post-task affect. The PANAS is a popular instrument to measure affect in SDT research and in exercise studies (Reed & Ones, 2006). The PANAS is an appropriate measure across exercise and nonexercise situations (i.e., laboratory studies), although it is a measure of HA affect only (Ekkekakis & Petruzzello, 2001). Therefore, a welcome contribution in the exercise context was to integrate LA items into the PANAS, as it had been done in other domains (e.g., Abercrombie, Kalin, & Davidson, 2005). Indeed, some researchers have substantiated that exercise can induce positive feelings of calmness and relaxation, typical of LA affect, and they argue that these affective properties should not be ignored (Blanchard et al., 2004; Gauvin & Rejeski, 2001). In this study, 11 items (5 positive) established by Feldman-Barrett and Russell (1998) to assess LA affect were used to supplement the original PANAS, which is comprised of 20 adjective words (10 positive and 10 negative [also see Abercrombie et al.]).

For each of the 31 adjectives, responses to the stem Indicate to what extent you feel this way right now, that is, at the present moment were rated from (1) not at all to (5) extremely. Examples of adjectives include “excited”
Table 1. Descriptive Statistics, Cronbach’s Alpha (α) Values, and Pairwise Comparisons for Situational Motivational Regulations for Running, Positive Affect, and Ratings of Perceived Exertion.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Running task (R)</th>
<th>Control task (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Intrinsic motivation running</td>
<td>5.80</td>
<td>0.82</td>
</tr>
<tr>
<td>Identified regulation running</td>
<td>6.35</td>
<td>0.47</td>
</tr>
<tr>
<td>Introjected regulation running</td>
<td>3.23</td>
<td>1.44</td>
</tr>
<tr>
<td>External regulation running</td>
<td>1.97</td>
<td>0.76</td>
</tr>
<tr>
<td>Amotivation</td>
<td>1.04</td>
<td>0.09</td>
</tr>
<tr>
<td>Pretask high activation</td>
<td>33.39</td>
<td>6.36</td>
</tr>
<tr>
<td>Post-task high activation</td>
<td>36.20</td>
<td>6.93</td>
</tr>
<tr>
<td>Pretask low activation</td>
<td>16.83</td>
<td>3.70</td>
</tr>
<tr>
<td>Post-task low activation</td>
<td>17.95</td>
<td>3.83</td>
</tr>
<tr>
<td>RPE</td>
<td>12.79</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Note. RPE = Ratings of Perceived Exertion.
Motivation variables averaged across tasks (used as covariates): intrinsic motivation (M = 5.75, SD = .88), identified regulation (M = 6.37, SD = .43), and introjected regulation (M = 3.24, SD = 1.27).

Distinct superscripts refer to significant pairwise comparisons: aPre- to postrunning task (HA), t(40) = 4.83, p < .001, d = .75. bPre- to postcontrol task (HA), t(40) = 8.35, p < .001, d = 1.30. cPostrun versus postcontrol (HA), t(40) = 4.83, p < .001, d = .75. dPostrun versus postcontrol (LA), t(40) = 5.38, p < .001, d = .76. ePostrun versus postcontrol (LA), t(40) = 5.38, p < .001, d = .76.

(positive, HA) and “serene” (positive, LA). Given the focus on positive affect in this study, only these items were summed, separately for HA and LA, and analyzed. Internal consistency values for all times points in the present study were robust and can be found in Table 1.

Situational motivation. The Situational Motivation Scale (SIMS; Guay, Vallerand, & Blanchard, 2000) was used to measure situational motivation for running. The SIMS consists of 16 items with four subscales that evaluate the different behavioral regulations (Standage, Treasure, Duda, & Prusak, 2003). Integrated and introjected regulations were excluded from the original SIMS to condense the scale (Guay et al., 2000). However, given the relevance of introjection in this study, an enhanced version of the SIMS was used, which contained four additional introjection items developed by Gillet, Vallerand, Lafrenière, and Bureau (2013). Responses to the stem why are you currently [about to run] are anchored on a 7-point Likert-type scale from (1) corresponds not at all to (7) corresponds exactly. A sample item is “because I think this activity is pleasant” (intrinsic motivation).

Average scores were calculated for intrinsic motivation, identified regulation, and introjected regulation. The psychometric properties of the SIMS are documented elsewhere, including significant factor loadings for the modified version with introjection (Gillet et al., 2013; Standage et al. 2003). The Cronbach’s alpha values of the given subscales in the present study are displayed in Table 1. As expected from a sample of active participants, scores on external regulation and amotivation were low and variance levels were negligible, which contributed to low internal consistency values. No further analyses were conducted on these regulations; no hypotheses had been forwarded for amotivation.

Intensity measure. In this study, the RPE scale (Borg, 1982) was used solely for descriptive purposes regarding the average perceived intensity of the running task and not for purposes of analysis. Readers can consult Guérin & Fortier (2012) for a more detailed examination of the intensity variable. The RPE consists of self-reported numerical values from 6 to 20 that are anchored with descriptors at every odd integer (i.e., 7 = very, very light; 13 = somewhat hard; 19 = very, very hard). The RPE has been popularized in studies of exercise and affect, and its validity and reliability are well established (W. Russell & Newton, 2008).

Design and Procedures
This experimental study was approved by the University of Ottawa Ethics Review Board. It followed a 2 (running, control) × 2 (pre, post) repeated-measures design. A traditional pre-post design was used based on the results of an important meta-analytic review (Reed & Ones, 2006) and given that the focus was, similar to others, on immediate changes in affect following exercise (Hallgren, Moss, & Gastin, 2010; Miller, Bartholomew, & Springer, 2005). Each participant attended two individual sessions (one week apart) at a campus laboratory. Blinding participants to the task they would receive at each session was expected to minimize carryover and expectation effects. Upon arrival, the women provided written consent after being informed of (a) the purpose to examine psychological factors during physical and/or non-physical activities (b) the protocol, namely that at the start of each session they would be randomly assigned to one of two tasks (i.e., running, quiet attention-control). In reality, a within-person comparison of the two tasks was sought and counterbalancing was used to assign half of the women to the...
running task at their first session \((n = 21)\) and the other half at their second session.

At the start of Session 1, each woman completed the intake assessment (i.e., background and LTEQ) followed by the SIMS and the PANAS promptly before being assigned one of the tasks. Session 2 followed a similar format with the omission of the intake assessment. Session 2 concluded with a short debrief (5 min) to inform participants of the components of this study.

**Running task.** Each participant was taken to a private exercise room equipped with a treadmill, a desk, and a chair. The treadmill control panel was physically detached from the running belt. This allowed the researcher to easily monitor and adjust settings according to the participant’s requests to mimic a self-paced, moderate-to-high intensity run. The participants completed a 2 to 3 min warm-up at an average speed of 5.17 km/hr. Next, the researcher sped up the belt to the participant’s desired pace. The researcher remained in proximity for any requests to alter the speed, the details and timing of which were duly noted. An average running pace was calculated by weighting any change in pace by the ratio of elapsed time at that pace. Conversation and eye contact between participant and researcher was kept to a minimum. Participants ran for 30 min as this can be considered to be a standard duration for examining acute exercise and affective states (e.g., Van Landuyt et al., 2000). Then, the belt was slowed to the initial walking speed for a 2-min cool down. The participant stepped off the treadmill and promptly provided their running RPE and responded to PANAS.

**Control task.** Each participant was taken individually to a private and quiet room equipped with a chair and a desk on which was laid out the daily newspaper and a small selection of general-topic magazines (e.g., home renovations, politics, and community). The researchers were very discerning in their selection of neutral reading material; suggestions of health and body image were minimized to avoid inflation/deflation influences on affect. This type of quiet, seated control task is common in exercise studies (e.g., Vocks, Hechler, Rohrig, & Legenbauer, 2009). The participant was instructed to occupy her attention with the provided material until the designated time had elapsed. The researcher busied herself in the adjacent workspace to mimic the procedures/presence of the running task. After roughly 35 to 37 min (running task total time with warm up/cold down), the participant promptly responded to the PANAS.

**Analyses**

All data were entered into SPSS Version 18.0. Data screening procedures were conducted according to guidelines set out by Tabachnick and Fidell (2007); this included assessments of data entry errors, missing data, outliers, normality and testing of basic assumptions of analyses of variance and regression analyses. Table 1 provides basic descriptive statistics and reliability analyses that were calculated for affect and motivation variables.

Using repeated-measures t tests and bivariate correlations, scores for the three motivational variables were examined across sessions to justify using average scores of situational motivation to simplify their inclusion as covariates. To test the preliminary hypotheses, a series of repeated measures ANOVAs were conducted. Specifically, the data for HA and LA affect were subjected to 2 (task: running, control) × 2 (time: pre, post) ANOVAs, respectively. A series of post hoc t tests with Bonferroni adjustment ensued to dissect the findings. Next, to test the moderating influences of situational motivational regulations as continuous variables, the ANOVAs were repeated by specifying intrinsic motivation as well as identified and introjected regulations independently as a covariate in each model (i.e., ANCOVA). The alpha level was adjusted for multiple tests \((p < .02)\). In graphing significant interaction(s), high and low values of the moderators (motivation covariates) were specified as one standard deviation above and below the mean (Aiken & West, 1991).

Last, to test exploratory hypotheses pertaining to the running task, separate hierarchical multiple regressions were conducted for postrun HA affect and postrun LA affect as dependent variables. Namely, for each of the two regression models, scores on the three motivational regulations were added as predictors in Step 2 after controlling for prerun affect in Step 1.

**Results**

**Preliminary Analyses**

Mean substitution estimation was used for missing data points (2.4%) as this amount was less than 5% (Tabachnick & Fidell, 2007). Using standardized scores, no univariate outliers were identified for any of the affect or motivation variables. Normality was confirmed by examining the distributions of the variables (i.e., histograms) and their skewness and kurtosis values. There were no issues with linearity, homoscedasticity or collinearity. Last, scores for motivation toward running remained stable from one session to the next \((ps > .05)\) and were highly correlated \((ps < .01)\); thus, average scores across session for the regulations were used as covariates in the ANOVAs.

**Sample and Running Task Characteristics**

Seventy-six women volunteered for this study. Thirty-four were deemed ineligible either on the basis of the aforementioned criteria or due to scheduling/contacting issues. One woman was excluded as she failed to attend both sessions. All demographic information as well as leisure time running behavior and in-laboratory running information of the final...
sample (N = 41) can be found in Table 2. Overall, the women in this study were middle-aged on average, were well-educated, and were primarily Caucasian. Healthy BMI and high activity levels were reported on the whole.

**Time and Task Effects**

To test the preliminary hypothesis, results of the repeated measures ANOVA for HA revealed a significant difference in positive affect between tasks (F[1,40] = 46.47, p < .001, η² = .54) and across time, F(1,40) = 5.83, p < .05, η² = .13, as well as a significant interaction between time and task, F(1,40) = 40.52, p < .001, η² = .50. Statistical values and effect sizes for post hoc analyses of simple effects can be found in Table 1. As expected, there was a significant increase in HA positive affect from pre- to postrunning task and a significant decrease from pre- to postcontrol task. For LA positive affect, there was a significant main effect of time, F(1,40) = 20.65, p < .001, η² = .34, but not of task, F(1,40) = 2.34, p < .13, η² = .06. The interaction between task and time was significant, F(1,40) = 4.48, p < .05, η² = .10. Follow-up pairwise testing of this interaction revealed that, although there was a marginal increase in LA positive affect after the running task (p = .54), this increase was actually more pronounced for the control task (see Table 1). Last, follow-up analyses revealed that for HA positive affect, levels postrun were significantly higher than levels postcontrol task. The reverse was found for LA positive affect, whereby levels postcontrol were significantly higher than levels postrun.

**Moderating Effects**

Repeated measures ANCOVAs were well suited to examine the moderating influence of motivational variables on time by task relationships. For HA positive affect, there was a significant three-way interaction between task, time, and introjection as a continuous covariate, F(1,39) = 4.71, p < .05, η² = .11. Figure 1 presents a helpful visual display of this complex association. As shown, for women with higher levels of introjection (i.e., greater than 1 SD above the mean) both the increase in HA affect from pre- to postrun and, interestingly, the decrease in HA from pre- to postcontrol were more pronounced than for those with lower levels of introjection. The three-way interaction between the identified regulation covariate, task, and time was not significant, F(1,39) = .92, p = .34, η² = .02, nor was the interaction significant for intrinsic motivation, F(1,39) = .23, p = .34, η² = .01. For LA affect, there

<table>
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<th>Variable</th>
<th>M or %</th>
<th>SD</th>
</tr>
</thead>
<tbody>
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<td>Age, years</td>
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<td>4.93</td>
</tr>
<tr>
<td>Education (percentage reporting ≥ university degree)</td>
<td>83</td>
<td>NA</td>
</tr>
<tr>
<td>Ethnicity (percentage of Caucasian)</td>
<td>90</td>
<td>NA</td>
</tr>
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<td>BMI</td>
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<td>LTEQ</td>
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<td>18.98</td>
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<tr>
<td>Leisure run-kilometers (min) per run</td>
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<td>2.39 (11.35)</td>
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<td>1.22</td>
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<td>In-laboratory-RPE</td>
<td>12.79</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Note. BMI = Body Mass Index; LTEQ = Godin Leisure Time Exercise Questionnaire; RPE = Ratings of Perceived Exertion.

*aThe range for the LTEQ was 27-116. The LTEQ score of 116 was an outlier on this variable. This score belonged to a participant heavily involved in triathlon training.

![Figure 1. High activation (HA) positive affect scores by level of introjection for (a) pre-post running task and (b) and pre-post control task.](image-url)
were no significant interactions between motivational regulations, task, and time.

**Motivation Effects for Running**

Hierarchical regressions were conducted separately for HA and LA positive affect to explore the influence of motivation during the running task specifically. All results can be found in Table 3. Starting with HA and after controlling for levels of prerun affect, intrinsic, identified and introjected regulation variables accounted for approximately 7% of the total 79% of variance explained in the model. Identified regulation was a significant and positive predictor of the increase in HA affect from pre- to postrunning, whereas introjection was also a positive and marginally significant predictor ($p = .05$). However, the beta for intrinsic motivation fell below significance levels, remaining so even when the other regulations were removed from the model (not shown). Motivation variables did not predict a significant amount of variance in post-run LA positive affect after controlling for prerun affect.

**Discussion**

**Strengths**

The objective of this experimental study was to examine the effect of situational motivation (for running) on the relationship between running (exercise) and immediate changes in positive affect. Examining person-centered and malleable SDT-based variables as modifying agents was unique to this study and provides innovative theory-driven insight regarding motivational circumstances that may inform underlying processes (Biddle & Ekkekakis, 2005). Key methodological features of this study lend strength to our findings, such as the use of a preferred exercise modality and a laboratory setting in which extraneous factors were minimized. This study adds support for the acute benefits of exercise on a key indicator of well-being given that increases in positive affective states surfaced in our sample (Biddle & Mutrie, 2008). As expected, participants experienced an increase in HA and LA positive affect after 30 min of running. Moreover, the increase in HA affect was not seen after the control task.

These findings add to the scarcity of experimental research in this area, particularly with women (Kull, 2002). This study supports ongoing efforts to understand the emotional benefits of regular exercise among women and it supplements literature attesting to the immediate affective benefits of running as a form of exercise for women (Butryn & Furts, 2003; Kelsey et al., 2006). From an applied standpoint, for instance in the context of lifestyle interventions targeting women, the findings hint that it may be worthwhile to emphasize the direct benefits of preferred exercise on indicators of well-being, such as positive affect.

**Self-Determined Motivation: Considerations**

The distinctive findings pertaining to motivation in this study, which accounted for a perceptible 7% of the 79% of variance in positive affect after controlling for prerun affect, help conjure up a number of interesting deliberations based on the principles of SDT, our guiding theoretical framework. We found that introjected regulation was a significant moderator of the relationship between running and affect, with levels of introjection being positively related to levels of postrun HA affect. Meanwhile, the moderating effects of self-determined regulations were not significant. Yet, identified regulation played a unique, positive role in the increase in positive affect with running, lending partial support to SDT (Deci & Ryan, 2002). This finding is consistent with Thøgersen-Ntoumani and Fox (2007), who found that identified regulation predicted physical well-being, although they did not examine exercise-related affective changes.

Still, our nonsignificant results for intrinsic motivation and the small (yet significant) effect for identified regulation do not fully align with SDT and past studies reporting significant and stronger associations between self-determination and exercise-induced changes in affect and well-being (Lutz et al., 2003; Standage et al., 2003; Thøgersen-Ntoumani & Ntoumanis, 2006). The finding that identified regulation predicted an increase in positive affect postrunning is
consistent with an SDT assertion that when individuals engage in exercise because they value the behavior and its benefits, they are more likely to feel better about themselves and overall (Ryan & Deci, 2000; Thøgersen-Ntoumani & Fox, 2007). Our findings for intrinsic motivation, however, tend to resonate with those of Gagné et al. (2003), who saw that incoming self-determined motivation among gymnasts did not significantly predict changes in indicators of well-being from pre- to postpractice. Although the results for intrinsic motivation appear counterintuitive given the strong enjoyment factor that defines this regulation, some authors have shown that identified motivation may be equally influential in predicting persistence in health behaviors, such as exercise, given that strenuous physical activities may not be perceived as inherently pleasurable (Wilson et al., 2004). Given that the women who participated in this study were persistent, high-intensity exercisers, this regulation may hold particular weight. It should be reiterated however that our regression analyses were underpowered and that the means for the self-determined regulations were high and the variances low. These descriptive statistics are not surprising given an active sample but could have led to restricted ranges and ceiling effects that weakened the explanatory power of these variables, an issue that was compounded by the large proportion of variance explained by prerun affect.

The results of this study also showed that scoring high on introjection was associated with experiencing higher levels of HA positive affect after running. From a conceptual standpoint, it could be that the source of introjection in the laboratory may be different from that of everyday running. Specifically, the level of introjection and its relationship with affect could be related to feelings of obligation to the study and a desire to please the researcher (experimental introject), rather than, or in addition to, a desire to not let oneself down, which would arise with regular day-to-day running (personal introject). Consequently, participants may feel more positive affect after the run as there is a release from the stress they have imposed on themselves, including pressures as research participants (i.e., “I should run because I agreed to do this study and/or I haven’t run today and I need to”). Altogether, these premises are consistent with the idea that individuals with greater introjection likely have more contingencies attached to the pleasure they derive from exercise (Guérin & Fortier, 2012). Conversely, self-determined regulations may be more stable and less vulnerable to situational fluctuations in sources of motivation (e.g., “I always value running”), thus exerting a lesser moderating influence on pre-post discrepancies in affect in the laboratory, as reflected by our findings.

Undoubtedly, the findings for introjection in our study are consistent with its characteristic ties to individuals’ self-worth (Deci & Ryan, 2002). According to Sabiston et al. (2010), “guilt may motivate reparative action” and thus, for some women, the running session may have improved affect by relieving negative feelings from not having yet exercised (p. 419). Similarly, positive affect can ensue following an activity for which one has an ego-involved goal orientation (a form of introjection), perhaps due to a relief from stress that arises from not having completed the activity/goal (Nix, Ryan, Manly, & Deci, 1999). Still, experts contend that such peaks in positive affect may be short-lived and probably not mentally restorative or conducive to better mental health (Nix et al., 1999). Thus, introjected runners may not benefit fully from the revitalization qualities of exercise. It may be worthwhile to assess feelings of vitality in similar studies in the future and to do so more longitudinally.

Given the above remarks, it may be prudent to hold reservations regarding possible moderating effects of introjection on changes in affect over the long term, although this was not tested in the present study. Although repeated positive affective experiences with exercise can sustain this type of behavior (Kwan & Bryan, 2010), this behavioral persistence can also escalate into rigid persistence, such as an exercise dependence. Hence, short-term postexercise peaks in positive affect among exercisers displaying high introjection may not translate into greater well-being over time, despite engaging in a physically active lifestyle. Stephan et al. (2010) saw high levels of self-determination as well as introjection in women who persisted with exercise, hinting that perhaps introjection must be coupled with more autonomous motivational forces. However, Stephan and colleagues did not assess emotional outcomes. Altogether, more attention is needed on the long-term effects of introjection on affective states, and this echoes views by Thøgersen-Ntoumani and Ntoumanis (2006).

Pulling from the experimental design, findings for the control task also provided worthwhile insights. Indeed, compared with women low in introjection, those with higher levels experienced a greater decrease in positive affect after completing the nonexercise quiet control task. This affect drop adds evidence to our supposition that, for these women, being unable to run or exercise may sustain feelings of guilt and thwart positive affective states. These findings are consistent with literature on exercise dependency cited above as well as with, we speculate, research on the influence of passion (Vallerand et al., 2003). Namely, when obsessively passionate individuals, as characterized by feeling compelled to engage in a valued activity, are deprived of the activity, they experience anxiety and worsening of affect (Vallerand et al., 2003). That some active women might experience more negative emotional states from a short relaxing activity is a cause for concern and hints at the overall complexity of the exercise-affect link.

**Exercise and Affect: Beyond Situational Motivation**

As can be appreciated from these deliberations, it is likely that other motivation-related variables within SDT or that align well with SDT, such as passion, may also underlie the
exercise-positive affect relationship. SDT provided a strong theoretical foundation for this study; within its hierarchical structure, we spotlight the unique, yet perhaps conflicting, effect of situational motivation. While this level of focus contributes to the literature on exercise and affect, future research may wish to also include how runners’ contextual motivation contributes to the exercise-affect relationship (e.g., motivational shift). Indeed, there may be a complex interrelationship between the regulations at various levels, other SDT constructs like the psychological needs, and exercise outcomes, such as affect (McDonough & Crocker, 2007; Sebire et al., 2009). This plausible complexity is worthy of further investigation.

Certain elements of the protocol in the current study were consistent with the guiding principles of SDT, thereby reducing confounding effects. Namely, only females who were familiar with running and who, presumably, felt competent with running, were selected to participate. In addition, the self-paced running task promoted participants’ autonomy and was expected to mimic a day-to-day run. However, the control task consisted of sitting in a quiet room reading the newspaper, which could have been a welcomed activity for participants with busy families and hectic schedules. The possible influence of reading material content on affect should also be acknowledged. Indeed, participants experienced a greater increase in LA positive affect (e.g., relaxed) with the control task compared with the running task. The lack of significant findings for LA for the running task resonates with a study by Bartholomew, Moore, Todd, Todd, and Elrod (2001) that failed to witness an exercise-related increase in the analogous state of tranquility. Moreover, these task-based differences for LA affect may not be entirely surprising given evidence that interoceptive cues arising from the physiological stimuli of an exercise task can increase levels of activation and alter affective valence (Bryan, Hutchison, Seals, & Allen, 2007; Ekkekakis 2003).

**Limitations and Summary**

Lastly, the findings of this study should be interpreted within the context of certain limitations. Given the small sample size, regression results must be taken as exploratory and indicative of trends between variables that will need to be examined in larger samples. Moreover, additional caution is required in interpreting the results for identified regulation given that this subscale revealed a low alpha in our sample, which is similar to that of other studies (e.g., Ntoumanis & Blaymires, 2003). In fact, the internal consistency values of the SIMS in this study warrant further testing of its psychometric properties in the exercise context. It may be a more psychometrically sound indicator of situational regulations in other domains and/or under manipulations of a participants’ autonomy (Guay et al., 2000; Muraven, Rosman, & Gagné, 2007).

In addition, despite the popularity of the pre-post design, several researchers have taken to assessing affect repetitively during exercise as this may be more sensitive to exercise intensity and resistant to dissipation effects (Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007; Ekkekakis et al., 2011). Moreover, the generalizability of the current findings to natural day-to-day contexts may be limited as the laboratory could have been experienced as cold and/or boring (e.g., no music, other runners, scenery), thus influencing responses. Although we attempted to minimize threats to internal validity as well as expectancy effects (e.g., via counterbalancing, “blinding” participants), it would be helpful in future studies to also consider a more extensive variety of compromising factors inherent in experimental designs, as outlined elsewhere in the literature (Reed & Ones, 2006; Thomas & Neilson 2001). Finally, more studies are also needed that draw on daily experience sampling whereby women’s motivational patterns and affective changes, as well as any reciprocal influences, can be modeled over time in natural exercise environments (Guérin, Fortier, & Sweet, 2013; Kwan, Hooper, Magnan, & Bryan, 2011).

In sum, and as guided by SDT, situational motivation can influence changes in positive affect acquired during an acute exercise session, although more work is needed on the long-term effects of a regulation guided by guilt and obligation. Moreover, given the large amount of variance it explained, it would be worthwhile to also consider ways of maximizing pre-exercise affect, in conjunction with motivation, to optimize postexercise benefits.

**Declaration of Conflicting Interests**

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**Notes**

1. As this study was part of a larger project examining psychological variables, physical activity and well-being in active women with multiple life roles, additional criteria that are not elaborated on in this paper were also imposed at the time of recruitment. That is, women also had to be mothers with at least one child under the age of 18 years living at home, and had to be employed a minimum of 30-hr/week (full time).
2. Items added to the PANAS to assess LA affect (Feldman-Barrett & Russell, 1998): relaxed, at rest, serene, calm, at ease (+); tired, sluggish, droopy, dull, bored, drowsy (−).
3. Although the full PANAS was administered, no analyses could be conducted on negative affect because this subscale (with and without LA items) demonstrated low internal consistency (Cronbach’s alpha) in the present study. Other authors have also
reported measurement issues with negative affect in the exercise context and this issue may play a role in the proper interpretation of results (Kwan & Bryan, 2010; Lutz et al., 2008).

4. Items measuring introjection in the enhanced Situational Motivation Scale (SIMS; Gillet et al., 2013): (1) Because I would feel bad not doing it, (2) Because I would feel guilty not to do it, (3) Because I want to avoid feeling guilty, (4) Because I would regret not doing it.

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