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Exploring the Effects of Cognitions ,Valence and Duration on Post-Exercise Mood

by

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Dedication

To my new wife and best friend, Marilou, without you, I probably would not be in the position I am today. Thank you for being who you are.

Abstract

The present study examined how ongoing thoughts during running affected exercise-induced mood changes and the role that the valence (i.e., a negative, neutral, or positive thought) of these thoughts had on these mood states. Female runners participated in one of three sessions: a) a 25 minute run at 70% heart rate reserve(HRR), b) a 40 minute run at 70% HRR, or, c) a 10 minute control condition. Pre-post mood measures were taken and the cognitions during running were later coded as body-relevant, body-relevant(other), or body non-relevant. Results indicated that there was a general improvement in mood post-run (i.e., tranquillity, positive engagement, and revitalization) regardless of duration. However, the 25 minute run produced significantly more positive engagement post-run than the 40 minute run. Subjective experiences significantly improved later in the run regardless of condition. However, they only predicted post-run mood states for the 25 minute run. Body non-relevant thoughts later in the run predicted post-run tranquillity whereas body-relevant thoughts later in the run predicted post-exercise physical exhaustion (valence did not moderate either relationship). Future directions of research were discussed.

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Introduction

The depth of knowledge concerning the effects of exercise on psychological well-being has grown substantially over the years. There have been ample reviews of literature and various meta-analyses done on the effects of exercise on psychological states such as depression, anxiety, and other mood states (Landers & Petruzzello, 1994; Morgan, 1994; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). However, according to O'Halloran (1994), there is a lack of research investigating the role of moderating variables (e.g., self-efficacy, self-esteem, motivation, cognitions, etc.) which may influence the direction and magnitude of mood changes as a function of exercise. She claims this is unfortunate because a signficant portion of the variance remains unaccounted for in the research addressing psychological states and exercise. This is of particular importance as exercise-induced mood states have yet to be empirically associated with an increase in exercise adherence and other health outcomes. According to Baron and Kenny (1986), the identification of moderator variables is one viable strategy toward developing an understanding of a phenomenon, which in this case, is exercise-induced mood changes. Researchers have also begun examining the impact of various physical activities (acute exercise) with differing intensities on psychological outcomes in recent years (cf. Rejeski, 1994), but further information is needed to paint a more complete picture of how and when psychological effects of exercise on feeling states can be expected (O'Halloran, 1994).

Purpose of the Study

Two variables that are gaining interest in the literature due to their effects on mood states are ongoing thoughts during exercise and the dosage of exercise (Goode & Roth, 1993; Rejeski, Gauvin, Hobson, & Norris, 1995). Although researchers have studied the concept of cognitive processes and their impact on sport performance, only recently have they argued that ongoing thoughts during exercise may have an impact on mood state changes accompanying exercise (Goode & Roth, 1993; O'Halloran, 1994). Furthermore, it is only recently that investigators attempted to examine the effects of exercise dosage on mood states during acute bouts of physical activity (Rejeski, 1994). In spite of these recent developments in the literature, there are many issues which need to be addressed. Therefore, the present study had three main objectives. First, a comprehensive review of the pertinent literature was conducted. This was done in order to identify gaps in the cognitive and dose-response literatures exploring the impact of exercise on psychological outcomes and to develop a rationale for the study. Second, the present study examined how ongoing thoughts during exercise affected exercise-induced mood changes and the role that the valence (i.e., a negative, neutral, or positive thought) of these thoughts had on these mood states. Finally, an attempt was made to determine how the duration of exercise may have affected these ongoing thoughts and post-exercise mood.

Delimitations

1. restricting sample to female runners
2. only using an indoor environment
3. restricted study to only two durations of exercise
4. valence ratings were taken after the exercise bout
5. restricted the control condition to 10 minutes

Limitations

1. although it is the intention to capture ongoing thoughts during running, one can not ignore the fact that some thoughts may be made up in order to have thoughts recorded for the experimenter.
2. there are also the potential concerns of using concurrent verbal reports which are discussed in the method section.

Dosage of Acute Exercise and Psychological Effects

In recent years, researchers in the field of exercise psychology have investigated the psychological outcomes of acute exercise. The data indicated that acute aerobic exercise was associated with favourable changes in mood, primarily through decreases in anxiety and depression (North, McCullagh, & Vu Tran, 1990; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). These findings are important as Gauvin and Rejeski (1993) have argued that "changes experienced during repeated exposure to activity, as opposed to long-term training adaptations are responsible for certain improvements in mental health" (p. 403). Furthermore, subjective states that occur during and following an activity are likely predictors of whether individuals are willing to adopt and maintain physically active lifestyles (Dishman, 1982; Rejeski, 1992). Therefore, the study of acute exercise effects may contribute to an understanding of the processes underlying long-term psychological responses to exercise. There is now evidence to support this view as it has been shown that acute bouts of physical activity increase states of energetic arousal measured immediately after cool down (Gauvin & Rejeski, 1993) and that participants experience reduced anxiety or a "quieting response" post-exercise (Petruzzello et al., 1991).

While the literature on the psychological benefits of acute exercise is increasing steadily, there is a lack of information examining the moderating role that the dosage of exercise (i.e., the various intensities, durations, and frequencies) has on mood states. That is, how much of a stimulus is needed to provide the desired effect, and are there levels that yield diminishing returns?

Existing Research

Farrell, Gustafson, Morgan, and Pert (1987) studied dosage effects on psychological outcomes by using 7 healthy trained men at three levels of intensity. They involved participants running for 80 minutes at 40% and 60% VO_{2max} and for 40 minutes at 80% VO_{2max}. They found reductions in tension which was measured by the Profile of Mood States (POMS: McNair, Lorr, & Droppleman, 1971), but only for the 60% and 80% runs. Rejeski, Gauvin, Hobson, and Norris (1995) suggested that this indicated an upper threshold for the anxiolytic effects of exercise in trained athletes.

Bulbulian and Darabos (1986) also studied highly fit participants using a cycle ergometer at 40% and 70% VO_{2max} for 20 minute sessions. Upon completion of the exercise bout, they used the Hoffman reflex (which quantifies muscle action potentials of the calf muscle in response to a single shock to the human tibial nerve) to evaluate central nervous system functioning in a post-exercise state (10 minutes of rest was used to allow the subjects heart rate (HR) to return to within 10 beats per minute of resting HR). Bulbulian and Darabos (1986) found that the largest reduction in sympathetic nervous system activity occurred after the 70% condition. This was seen as evidence for reduced tension.

Steptoe and Cox (1988) studied 32 female students in a single-session experiment during which they carried out two 8-minute trials of high-intensity exercise and two 8 minute trials of low-intensity exercise. One high and one low-exercise trial were accompanied by music; the other two trials were accompanied by a metronome. Mood was assessed using a modification of the Profile of Mood Sates before and immediately after each trial. Participants were divided into fit and unfit groups based on heart rate responses during high-exercise trials. Overall, they found that high-intensity exercise led to increases in tension/anxiety and fatigue while positive mood changes (vigour and exhilaration) were seen following low-intensity exercise only regardless of fitness level. The findings with respect to intensity level have been replicated on two different occasions (Roy & Steptoe, 1991; Steptoe & Bolton, 1988) which Rejeski, Gauvin, Hobson, and Norris (1995) suggested showed that lower levels of work intensity were better than more demanding bouts of exercise if the goal was to enhance mood states. However, as Rejeski, Hardy and Shaw (1991) have indicated, it is important to underscore the fact that these observations were made directly after exercise which was an aspect of the design that may lead to a misrepresentation of the data. For example, Roy and Steptoe (1991) have actually indicated that these negative effects are short lived.

Most recently, Rejeski, Gauvin, Hobson, and Norris (1995) investigated the hypothesis that the effects of acute aerobic exercise on feeling states may be influenced by the objective dose of the activity, subjective responses during the activity, and preexisting feeling states (prior to exercise). They studied 80 college-age women who were considered moderately fit. Each participant completed baseline and post exercise measures of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, A., 1988) and the Exercise Induced Feeling Inventory (EFI; Gauvin & Rejeski, 1993) and were then randomly assigned to 1 of 4 conditions: attention control for 10 minutes, or exercise for 10 minutes, 25 minutes, or 40 minutes. Levels of exertion and affect were assessed during exercise using the Ratings of Perceived Exertion Scale (RPE; Borg, 1985) and the Feeling Scale (FS; Hardy & Rejeski, 1989). Post-testing occurred 20 minutes following the activity. Rejeski et al. (1995) found no evidence for an objective dose-response effect between single bouts of aerobic exercise and feeling states assessed 20 minutes later. However, exercise did enhance revitalization in comparison with the control condition, but only for participants scoring low to moderate on the pretests. In-task feeling states did predict post-exercise revitalization; that is, the women who were more positive during the exercise bout had the largest revitalization scores after exercise. This supported Rejeski's (1994) claim that feelings toward an exercise stimulus are an important aspect of understanding how physical activity influences psychological well-being.

Methodological Concerns

As was demonstrated in the dose-response literature, there were contradictions with respect to the role that the dosage of exercise played in moderating mood states. Farrell et al. (1987) and Bulbulian et al. (1986) found that higher intensity exercise (60 - 80% HRR) was more beneficial (i.e., reduced tension) for fit individuals which contradicted Steptoe and Cox's (1988) findings. However, these inconsistencies may be due to the fact that post-exercise mood states were measured at different times across studies. In order to address this methodological concern, it may be of use to compare exercise intensities, durations, or frequencies in a mixed within/between subjects design, measuring post-exercise mood consistently with respect to HR rather than having a set time period after the exercise bout. Another issue that has not been addressed in the dose-response literature is how cognitions during exercise may affect the participants' subjective experiences and whether the dosage of exercise affects these cognitions.

Thoughts During Exercise: Existing Literature

As was demonstrated above, researchers investigating the psychological effects of exercise on well-being are exploring mood benefits associated with participating in acute exercise bouts at various intensities (Steptoe & Cox, 1988; Rejeski, Gauvin, Hobson, & Norris, 1995). This research typically required participants to cycle or run at a given intensity and to complete a standard battery of mood questionnaires. However, O'Halloran (1994) suggested that this methodology was adequate for ascertaining the existence of exercise-induced mood changes, but it did not aid in the discovery of moderator variables. As Baron and Kenny (1986) have suggested, the identification of moderator variables may be one viable strategy towards developing an understanding of such a phenomenon. This is because moderator variables specify when certain effects will hold (Baron & Kenny, 1986). Therefore, their discovery from an exercise standpoint, may contribute in understanding which types of variables (e.g., cognitions, exercise duration, etc...) enhance exercise-induced mood states and when.

While many physiologically-related theories exist in explaining psychological processes occurring with exercise (e.g., endorphins responsible for runner's high), there is little research examining other psychological variables that may act as moderators. In particular, Rejeski and Thompson (1993) have indicated that the area of cognition and exercise has been neglected. There are only a few studies examining thought processes co-occurring with exercise. One of these models is Morgan and Pollack's (1977) association-dissociation model used to identify cognitive strategies adopted by elite marathon runners.

Association-Dissociation Model

Morgan and Pollack (1977) suggested that the cognitions that runners focused on during a marathon had an impact on their running time. They conducted in-depth interviews with twenty elite American marathon runners to determine if differences in thinking between elite and non-elite runners could be identified. The authors attempted to distinguish the two groups via dissociative and associative modes of thought. Dissociative thought was defined as thinking about anything other than the somatic perceptions (e.g., thinking about building a house) arising during exercise. On the other hand, associative thought occurred when athletes focused on physiological processes such as breathing, muscle cramps, and heart rate.

The results indicated that non-elite runners tended to dissociate while running to keep their mind off the pain of long-distance running. However, elite runners tended to use a mixture of dissociation and association. The elite runners used association to monitor their bodies and judge the amounts of energy reserve they had during a race (Morgan & Pollack, 1977) and tended to dissociate when faced with a difficult portion of the course (Morgan, 1978). As O'Halloran (1994) has pointed out, Morgan and Pollack (1977) and Morgan (1978) only studied the relationship between thoughts and performance which prevented the drawing out of any evidence of the relationship of thought content and feeling states.

Sachs (1984) attempted to further refine and improve the association-dissociation model of cognitive strategies by making the association/dissociation definitions more precise. Sachs (1984) proposed that not all runners use the same cognitive strategies when dissociating. He defined association as mainly a "left-brain" activity because of its analytical nature while investigating the "runner's high" phenomenon. He also saw dissociation as seeming to be either "left" or "right-brain." An example of a "left-brain" strategy was solving a mathematical problem whereas enjoying music was an example of a "right-brain" activity.

Sachs (1984) proposed that "right-brain" activity would be conducive to "runner's high" and a better perceived run as a result. He tested this hypothesis by interviewing 60 runners and found that although it was difficult to categorize them as associative or dissociative because the runners often shifted from one cognitive strategy to the other, 68% of his sample used dissociative strategies most of the time, 25% used associative and 7% were mixed. These runners were then randomly assigned to one of three groups: a) the associators who were asked to use association techniques by concentrating on their body sensations, analysis of stride, and rate of respiration; b) the "left-brain" dissociators who were instructed to either solve a personal problem or to count objects they saw along the route of their run, (i.e., either mailboxes or cars); and c) the "right-brain" dissociators who were asked to think of music without words or to paint a mental picture of their friend or spouse. The runners were then asked to use their assigned cognitive strategy when running the second last mile of their run.

Sachs (1984) did not succeed in finding any performance differences, but he subsequently offered various explanations. He found that using experienced runners was difficult because they had already determined which cognitive strategy worked best for them. Sachs (1984) claimed that asking these runners to adopt a strategy other than their own may have been intrusive. As a result, Sachs (1984) suggested that the use of associative and dissociative strategies must be further explored and the approach should be carefully planned to be able to overcome some of the resistances offered by the study participants.

Thought Processes and Performance

While Morgan and Pollack (1977) and Sachs (1984) concentrated their efforts on developing the associative/dissociative model itself, Johnson and Seigal (1992) focused more on the application of the model (O'Halloran, 1994). They used the association/dissociation model to investigate the effects of cognitive strategies on the perception of effort. Fourty-four participants were assigned to each of four treatment groups: a) the control group which was not given any instruction on what to focus on; b) the association group which was told that the purpose of the study was to report physiological processes including focusing on breathing and tension; c) the internal dissociators group which was asked to recall every teacher's name since kindergarten; and d) the dissociator's group which was engaged in conversation with two research assistants. All of the participants cycled on a cycle ergometer for 15 minutes at 60% of their VO_{2max}. Upon completion of the exercise bout, the participants were asked to report their rating of perceived exertion (Borg & Noble, 1974) during the exercise bout (retrospectively).

The results of the group asked to associate had higher RPE's than the group asked to internally dissociate, indicating that although the groups were working at the same intensity, the perception of effort was not the same (Johnson & Siegal, 1992). As O'Halloran (1994) has suggested, when participants were asked to monitor their physiological processes, they perceived their effort as greater than those who performed internal dissociation.

There were no differences found between the external dissociation group and the control group and Johnson et al. (1992) claimed that the control participants (not instructed how to think) may have been using some kind of dissociation technique. The authors suggested that future research should use quantitative means to measure information processing. According to O'Halloran (1994), although Johnson et al.'s (1992) study was methodologically superior to Morgan and Pollacks (1977) and Sachs (1984) because control groups were used, it did not examine the influence of thoughts on mood.

Internal versus External Focusing

The research on associative and dissociative cognitive strategies has continued to evolve since its outset. For example, some researchers have used other names to describe the phenomenon of dissociative and associative thoughts during running (O'Halloran, 1994). Pennebaker and Lightner (1980) have used internal cues for association and external environmental cues for dissociation. They examined the idea that attending to external cues would reduce awareness of internal cues and fatigue. Pennebaker and Lightner (1980) conducted two experiments involving prolonged physical exercise so that both internal and external cues would be readily available to the participants. In their first study, 57 male students were asked to listen to different sounds on a walkman while walking at a constant rate on a treadmill (indoor environment). In the first session, participants walked for ten minutes without any sound being emitted from the walkman they were wearing. In the next session, participants were randomly assigned to one of three conditions: a) participants heard street sounds (external cue); b) participants heard an amplification of their own breathing (internal cue); or c) participants heard nothing. The results indicated that participants who heard the distracting sounds (passing cars, parts of a conversation) reported less fatigue and other symptoms than the participants who did not hear anything. On the other hand, participants who heard an amplification of their own breathing reported significantly more fatigue which suggested that bodily information (associative thought/internal cue) increased perceived fatigue. However, the participants did not just focus on their breathing, but an amplification of it. This produces an interpretive problem because breathing is probably a normal cue to level of exertion. The amplification could have resulted in individuals thinking they were working harder than they actually were. A normal breathing focus group versus an amplified breathing group to ease out this potential confound.

In a second study, Pennebaker and Lightner (1980) used a field setting (outdoor environment) where participants jogged either a cross-country course demanding constant monitoring of the external environment or a repetitious lap course requiring very little external focus (on alternating days) over a period of 10 days. Both courses were 1800 m long. It was hypothesized that there would be more fatigue reported on the track because it lended itself to a focus on internal cues. On the other hand, the trail would force the runner to pay attention to the environment (external cue) and should report less fatigue as a result. Pennebaker and Lightner (1980) found that there were no differential reports of fatigue or symptoms, but participants ran faster on the wooded cross-country trail than when running the same distance on the lap course. They proposed that the cross-country runners attended more to their surroundings than did the track runners. Thus, the runners on the wooded trail were less aware of their internal sensations (associations/internal cues) of fatigue, resulting in faster times.

O'Halloran (1994) suggested that caution should be exercised when drawing conclusions from these two studies. She claimed that in the treadmill study, the control condition could have elicited an internal or an external focus. The street sounds probably elicited the external focus because of the novelty. For the breathing condition, since it was repetitive, the participants could have "tuned out" after a while. In addition, she claimed that it was relatively safe to say that the participants running on the cross country trail were using external environmental cues because they had to be vigilant in spotting rocks and other potential hazards. However, when running on the track, participants could have potentially been using either an internal or external focus or a combination. Manipulation checks, in this case, should have been performed.

Fillingim and Fine (1986) claimed that it was inferred by Pennebaker and Lightner (1980) that the cross-country joggers attended externally and the lap runners internally because there were no significant differences between them with respect to fatigue or symptoms, despite the difference in running speed. However, they claimed that the above assumption needed empirical support. Therefore, they attempted to manipulate attentional focus directly. Fifteen participants ran 1 mile under each of three conditions: a) "word-cue" where participants were required to focus externally by listening for and counting the number of times a target word (dog) was heard over headphones; b) "breathing" where participants were directed to attend to their own breathing and heart rate; and c) a control where participants simply jogged while wearing headphones. The results indicated that participants reported significantly less symptomatology, particularly exercise-relevant symptoms (e.g., fatigue, joint soreness, and cramps) in the word-cue condition (external attentional focus) than in the breathing (internal attentional focus) or control conditions (see also Fillingim, Roth, & Haley, 1989).

Are dissociative thought and external focusing the same?

Morgan and Pollack (1980) and Pennebaker and Lightner (1980) described dissociation and external focus in similar fashions. Padgett and Hill (1989) expanded on these concepts, explaining the subtle differences between the two. They claimed that internal dissociation implied cognitive strategies such as listening to imaginary music, writing imaginary letters or solving hypothetical problems. However, an external focus implied paying attention to environmental cues. All authors did agree on the definition for associative thought.

Padgett and Hill (1989) attempted to contrast the two distraction hypotheses and proposed that the external focus would lead to better performance than the dissociation strategy. In an attempt to replicate the findings of Pennebaker and Lightner (1980), these authors used a bicycle ergometer and instead of the headphones, they asked the participants to fill out a questionnaire while cycling to provide an external distraction which could be verified. Twenty participants were asked to pedal at a comfortable rate and intensity for 30 minutes. They were counterbalanced across two conditions: associative or external focus. Members of the associative group were asked to focus on their heart rates and leg muscles while the external focus group was required to fill out a questionnaire on body image. On a different day, the groups were reversed. The associative group did the questionnaire and the external focus group did the associative thought. As a form of a manipulation check, the participants were asked how much of a distraction the questionnaire was and how much they payed attention to their muscles in each of the two conditions. Results indicated the estimated time of exercise was lower and the perceived effort was lower in the distraction condition.

In the second portion of the study, Padgett and Hill (1989) attempted to identify the better strategy in increasing performance. The researchers hypothesized that the fastest running times would be turned in by the external focus individuals, followed by the dissociators, followed by the associators. For the purpose of this study, twelve male track athletes were used. Thus, unlike in previous research, an attempt was made at using participants with a more uniform and comparable fitness level. All participants participated in the control condition where they were instructed to run at a normal pace. The dissociative condition participants were asked to imagine themselves sitting on a beach or solving a mathematical problem while the external focus participants were asked to count the number of hurdles on the track and the number of cars on the road. For the manipulation check, participants were asked to report what they were thinking of during the exercise bout (post-exercise, retrospectively). The dissociative thinkers reported singing songs, writing letters and thinking of a variety of pleasant things while the external focus participants were able to give accurate descriptions of track conditions and various environmental factors. Unfortunately, the authors did not give any indication of what the control condition participants were thinking of. The results indicated that when 7 of the 12 athletes ran in the external focus category, they produced their fastest times. Based on these results, the authors concluded that an external focus strategy was probably a recommended cognitive strategy for tasks requiring endurance such as cycling or running.

Methodological Concerns

As O'Halloran (1994) has pointed out, Pennebaker and Lightner (1980) did not attempt to measure thoughts during either the treadmill or the jogging study. The same can be said about Fillingim and Fine (1986). Therefore, it is difficult to make assumptions about whether internal/external focusing is better in reducing physical symptoms and fatigue because it is not known what the participants were thinking about during the exercise bouts. This is of particular importance because, as was discovered in the association/dissociation literature, runners tended to oscillate between associative/dissociative thought, or in this case, internal/external focusing. Therefore, it is unclear whether the experimental conditions elicited the intended train of thought.

Although Padgett and Hill (1989) attempted to monitor the intended train of thought by asking their participants what they thought about during their exercise bouts, this retrospective method may not produce the accuracy needed to validate the intended train of thought. This is because Ericsson and Simon (1993) suggest that recall from long term memory would be difficult and incomplete with durations longer than 10 seconds. In this case, the use of concurrent verbal reports would have allowed researchers to determine what the participants were thinking about during the actual exercise bouts.

Quantifying Cognitive Strategies

Schomer (1986) devised a study in which he recorded associative and dissociative thought by having participants (ranging from novice to elite marathon runners) talk into a cassette recorder while running on several different occasions. This was done in an attempt to quantify associative and dissociative cognitive techniques. Once each training run was completed, an RPE rating was obtained (retrospectively). O'Halloran (1994) claimed that this methodology was a considerable improvement over any previous studies in that it eliminated the inherent problems of retrospective data. However, there was not enough data recorded in order to determine the number of sessions each participant participated in.

Schomer (1986) attempted to place the recorded thoughts of his participants into ten categories. The categories included: a) *feelings and thoughts* (e.g., "I feel fine"); b) *body monitoring* which were thoughts concerning physiological processes such as breathing; c) *command and instruction* (e.g., thoughts about slowing down or relaxing the upper body); d) *pace monitoring* which were thoughts on the general progression of the training run (e.g., "only a little bit to go"); e) *environmental feedback* which were thoughts concerning the environment (e.g., temperature); f) *reflective activity thoughts* which were thoughts on past and future issues on running (e.g., thoughts of upcoming races); g) *personal problem solving* (e.g., wondering what your spouse was doing); h) *work, career, and management* which contained thoughts about work or chores to be done at home; I) *course information* which contained thoughts like the placement of the other runners; and j) *talk and conversational chatter* with other runners. Schomer (1986) reported that the categories of *feeling and affect, body monitoring, command and instruction,* and *pace monitoring* resembled an associative strategy. The remaining categories of *environmental feedback, reflective activity thoughts, personal problem solving, work, career and management, course information,* and *talk and conversational chatter* were said to be dissociative in nature.

Schomer (1986) related his conclusions to Nideffer's (1981) Attentional Style which classified ways that people pay attention to various stimuli into one of four dimensions: broad external, broad internal, narrow external and narrow internal. Schomer (1986) concluded that *feelings and affect, body monitoring,* and *command and instruction* reflected a narrow attentional style. Although Easterbrook (1959) supports the idea that attention or cue utilization narrows as emotional intensity increases, O'Halloran (1994) claims there is no evidence that these concepts are related to the perception of effort. According to Schomer (1986), *pace monitoring* reflected a narrow external focus of attention. In addition a broad internal attentional style, which is also dissociative , comprised *reflective activity thoughts, personal problem solving,* and *work,* *career, and management* whereas broad external styles were *course information* and *talk and conversational chatter.*

Regardless of reflecting Attentional Style, O'Halloran (1994) claimed that the categories themselves were somewhat disputable in their descriptions. For example, Schomer (1986) identified the categories of *body monitoring* and *command and instructions* as distinct. An examination by O'Halloran (1994) of the examples given for *command and instructions* revealed that this category should have been included under *body monitoring*. For example, she gave the example of how a runner telling him/herself to breath deeply exhibited a form of *body monitoring*. She claimed that examples used in the category description also revealed that some of the thoughts may have been associative in nature. For example, "I remember the way I struggled up this hill" was associative because body monitoring was involved in assessing a struggle. O'Halloran (1994) claimed that struggling up a hill implied shortness of breath, muscle soreness, and/or increased heart rate which were all physiological processes.

The results indicated a positive relationship between associative mental strategies and perceived effort, that is, the more associative the mental strategy, the more perceived effort the participants felt. However, O'Halloran (1994) pointed out that in Schomer's (1986) study, there was no mention of any measure of heart rate, maximal oxygen capacity, and no indication of the intensity level at which the participants were working. Furthermore, she claimed that it is well known that ratings of perceived exertion vary with heart rate and/or exercise intensity which meant that it was impossible to conclude from Schomer's (1986) study that associative thinking is related to perceived exertion without knowing the true intensity of the training run. Therefore, although Schomer's use of moment-by-moment data was a considerable methodological improvement over Morgan and Pollack's (1977) retrospective data, the categories for thoughts and the interpretation of results were questionable (O'Halloran, 1994).

In a subsequent study, Schomer (1986) attempted to teach runners to think in an associative manner. The participant sample included four novice, two average and four superior runners. Trainers and athletes communicated through light-weight, hands-free radios. During the five 45 minute training run intervention sessions, runners were asked to verbalize their thoughts. Trainers, through the five sessions, encouraged associative thought and discouraged dissociative thought. Runners were then asked to complete the RPE scale following the session (retrospectively). The results indicated that eight of the ten participants progressed toward the more associative thinking. Along with this progression, Schomer (1987) noted an increase in perceived effort.

Again, O'Halloran (1994) has pointed out methodological concerns that do not coincide with the definitions of associative and dissociative thought. For example, she suggested that the trainers' communication with the runners offered the runners a dissociative outlet for their thoughts. Verbalizing thoughts when someone is simultaneously listening may not have been conducive to saying exactly what was on one's mind. Schomer (1987) also proposed that runners could learn to categorize their thoughts and determine if they were associative or dissociative when the trainers were not available. However, O'Halloran (1994) claimed that by reflecting and analyzing thoughts, participants would somewhat remove themselves from the thought which could be considered a form of dissociation since time spent actively categorizing a thought was not spent on pure association.

Cognitions and Psychological Outcomes

Goode and Roth (1993) were the first researchers to examine thoughts during running and their effects on mood. They developed the Thoughts During Running (TDR) questionnaire through the use of interview data. An exploratory factor analysis produced a five-factor structure consisting of 32 items. The resulting questionnaire was administered to 533 university students who reported walking or running for exercise. A confirmatory factor analysis revealed a five factor solution. They were *associative* (e.g., how my body feels) , *external surroundings* (e.g., nature), *interpersonal relationships* (e.g., my girlfriend or boyfriend), *daily events* (e.g., financial matters), and *spiritual reflection* (e.g., religious thoughts).

In a follow up to the scale development of the TDR, the *Profile of Mood States* (POMS; McNaire, Lorr, & Droppleman, 1971) was administered to 150 male and female experienced runners at the beginning of an individual training run and once again following the run. The results indicated that decreases in tension were associated with thinking about *interpersonal relationships*, and increases in vigour with thinking about *external surroundings, interpersonal relationships*, and *daily events.* Increases in fatigue were related to *associative* thought, but decreases in fatigue were reported for *interpersonal relationships* and *daily events.* O'Halloran (1994) claimed that although these results were interesting, they were limited because measures were taken post-exercise and retrospective data may not be as reliable as obtaining moment-by-moment data during the activity.

Thus far, it has been shown that there is a lack of conceptually-driven thought categories. It would appear that the categories utilized emerged from the data instead of being established on a priori theoretical foundation. Similarly, the use of data-driven definitions as opposed to theory-based ones impedes definition uniformity, making the results incomparable. Most notable is the lack of methodological strength. Practices such as using retrospective data, not recording exercise intensity, using heterogeneous samples, and omitting the use of manipulation checks weaken the value of practical implications that can be drawn from the results (O'Halloran, 1994).

In order to overcome some of the limitations of the previous research and to identify moderator variables, O'Halloran (1994) studied the role of ongoing thoughts about mood and emotional intelligence (Salovey, Mayer, Godman, Turvey, & Palfai, 1992) in moderating the effects of acute exercise on mood. The ongoing thoughts about mood was referred to as meta-mood (Salovey & Mayer, 1990). Emotional intelligence had three underlying components which were *attention* (the extent to which individuals typically observe the mood that they are experiencing), *clarity* (a participant's ability to identify and label moods), and *Mood Management* or *maintenance repair* (the effectiveness with which a person can change their mood) (Salovey et al., 1992).

In O'Halloran's (1994) study, twenty-four female college students (12 physically fit-active and 12 physically unfit-inactive women) participated in two laboratory sessions. The first session was an attention control condition where each participant was familiarized with the laboratory procedures. The second session required the participants to exercise at 70% of maximum hear-rate reserve for a period of 30 minutes. Mood was measured pre-exercise and 30 minutes post-exercise with the Positive Affect-Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), the Activation-Deactivation Adjective Checklist (Thayer, 1978) and the Feeling Scale (Hardy & Rejeski, 1989) while thoughts about ongoing mood were assessed with a modified version of the State Meta-Mood Scale (Mayer & Gaschke, 1988). Emotional intelligence was measured with the Trait Meta-Mood Scale (Salovey et ai., 1992).

The results indicated that changes occurring at different measurement times were consistent with those typically reported in the literature (e.g., Morgan, 1994), but that trait meta-mood played a moderating role for the perception of energy. Specifically, individuals who generally payed more attention to their moods reported greater perceived energy post exercise than they did pre-exercise or either of the control conditions. Conversely, those individuals who did not pay much attention to their moods perceived that they had less energy in the post-exercise condition than at any other time. Individuals who had an ability to regulate their mood also perceived higher levels of energy in the post-exercise measures than in the pre-exercise measures. But, no moderating role was observed for ongoing thoughts about mood (O'Halloran, 1994).

The results of the above study did not support the existence of a moderating role of selected thoughts on exercise-induced mood. However, O'Halloran (1994) suggested that the meta-mood scales used may not have properly assessed what the thoughts were and how the participants were processing these thoughts. Furthermore, she claimed that perhaps transient thoughts moderated the exercise-induced moods, but the approaches previously used may not have allowed for this issue to be addressed.

O'Halloran (1994) attempted to overcome the above limitations by examining the role of thoughts and level of thinking during running in moderating exercise-induced mood. A high level of thinking was defnined as having thoughts which were highly self-reflective and demonstrated an awareness of emotion while low level thinking was mundane and void of any self-awareness. Eleven habitual runners were recruited to participate in two running sessions. Female runners were used because it has been reported that women are more sensitive to changes in positive and negative emotions (Larsen & Deiner, 1987).

The first exercise session was a free-exercise control session where the participants ran at their own preferred pace. The second session had participants run at 70% of their maximum heart-rate reserve (HRR). The two sessions were counterbalanced. Mood was assessed through the Exercise-Induced Feeling Inventory (Gauvin & Rejeski, 1993) and the Feeling Scale (Hardy & Rejeski, 1989) at pre-exercise and 30 minutes post exercise. Thoughts and level of thinking during running were recorded through a *stream-of-consciousness* technique (James, 1890; Pennebaker, 1989) asking the participant to talk into a hand-held tape recorder for five minutes during the run. The first of two measures of level of thinking was taken 15 minutes after the start of the run and the second was taken 35 minutes after the start. The participants ran for a total of 40 minutes. Thoughts recorded while the participants ran were coded into different categories according to their content. The categories were *valence* (i.e., a positive, negative, or neutral thought), *people, associative, inner thoughts and feelings, daily events, interpersonal relationships,* *external surroundings, body monitoring, problem solving,* and *spiritual reflection.*

The results of the study indicated that the content of thoughts, specifically, *inner thoughts and feelings, body monitoring,* and *problem solving* were significant predictors of level of thinking in that higher instances of *inner thoughts and feelings* and *problem solving* were associated with higher levels of thinking while body monitoring was associated with lower levels of thinking. In addition, level of thinking was found to play a moderating role in mood states. Specifically, for the FS, tranquility, and positive engagement subscales of the EFI at the pre-exercise measurement time, as favorable moods increased, level of thinking also increased. However, in post exercise, regardless of level of thinking, the mood was favorable (O'Halloran, 1994).

O'Halloran (1994) suggested that in future studies, an examination of level of thinking at pre- and post-exercise should be undertaken to examine in more detail the changes that occur in both content of thoughts and level of thinking as a function of exercise. She claimed that this could be done by further refinement of the thought categories. For example, *spiritual reflection* did not appear in any thought, however, Goode and Roth (1993) included this category in their analysis and O'Halloran (1994) suggested that this discrepancy should be considered.

Present Study

There has been much work done addressing associative and dissociative thoughts during running. This research has progressed from a simple two-category association/dissociation model to a multi-factor model. However, it is only the definition of dissociative thought that has been refined. Originally, Morgan and Pollack (1977) defined dissociative thought as anything that was not associative (i.e., the focus on physiological processes). Sachs (1984) took this one step further and divided dissociative thoughts into left-brain and right-brain thoughts. Pennebaker and Lightner (1980) introduced the external environmental cues as an additional form of dissociation. Recently, Goode and Roth (1993) and O'Halloran (1994) have grouped *interpersonal relationships, daily events,* and *spiritual reflection* under dissociation. While each author's definition of dissociative thought has merit, it excludes other thoughts that may be important.

O'Halloran (1994) has argued that the subcategories introduced within the associative/dissociative model have been disputable with respect to definitional uniformity because they were statistically driven (for classification purposes). By claiming this, she is inherently suggesting that the categories be theoretically developed a priori in order to avoid further ambiguities when it comes to classification. Although, her methodologies were superior to the previous studies, she too, has introduced confusion to the literature with respect to the categories she used. For example, she claimed that "I wonder what I will get my mother for her birthday" fell under the *problem solving category* which it does. However, this example could also fall under the *people* category as well as the *interpersonal relationships* category. Within her studies, she allowed for the classification of a thought to be in more than one category which truly does not allow for any distinction of thoughts to be made. It might be better to reduce the number of categories with clear distinctions in order to truly distinguish a thought. By doing so, one may be able to truly make an association between cognitions during running and mood.

As can be seen, more attention needs to be brought to associative and dissociative thought in order to develop uniform operational definitions. One potential way of doing this is by introducing new categories. Therefore, the purpose of the present study was to further examine the moderating role of thoughts during running on mood by introducing three new thought categories in an attempt to resolve the current issue. The three new thought categories were body-relevant thoughts which were any thoughts directly related to the body (e.g., my knees hurt), body-relevant thoughts (other) which were body-related thoughts that did not involve any type of physicality (e.g., I'm hot) and body non-relevant thoughts which were any thoughts that were not body-relevant or body-relevant (other) (e.g., I have to get the car fixed).

From reading over the literature presented thus far, it may appear that body-relevant thoughts are the same as associative thoughts, but, they are not. O'Halloran (1994) gave an example of an associative thought as, "My running really makes me feel good." This is an associative thought, but it is not a body- relevant thought because the thought is not directly related to the body. In order for this thought to be considered body-relevant, an example may be, "My knees don't hurt while I run which makes me feel good." By making reference to the knees, it is clear why the person is feeling good. There is no ambiguity. However, by using the associative thought category, one may never know why running makes him/her feel good. The distinction between an associative thought and a body-relevant thought may be of particular importance in clearing up some of the confusion in the literature.

In addition to refining the categories as suggested by O'Halloran (1994), the present study attempted to examine three pending questions with respect to ongoing thoughts during running. First, do body-relevant or body-relevant (other) thoughts affect mood (post-exercise) and in what direction? Second, does the valence (i.e, whether the thought is positive, negative, or neutral) or some other aspect of a body-relevant or body-relevant (other) thought moderate mood. Third, does the valence of any thought moderate mood?

Another issue that was addressed earlier in the review was the contradictory results found in the dose-response literature with respect to the dosage of exercise needed to moderate mood states. As was stated, certain studies (Farell et al., 1987; Bulbulian et al., 1986) claimed that high dosages of exercise produced more favourable mood states while others claimed there were no differences (Steptoe & Cox, 1988; Roy & Steptoe 1991). Therefore, it appeared that further studies were needed in order to clarify this issue. The present study used a between-subjects design (manipulated the duration of exercise) and measured post-exercise mood when the participants heart rates returned to within 10 beats of what they were upon entering the exericse site in an attempt to introduce a method which would allow for consistency in the future. Furthermore, the present study examined how thoughts during running may have affected the participants' subjective experiences and whether the dosage of exercise affected these cognitions.

O'Halloran (1994) manipulated the intensity of exercise (i.e., 70% HRR and free exercise control) in her study. However, no differences were found between the two conditions with respect to mood states. Therefore, the present study manipulated the duration of exercise (i.e, 25 minute and 40 minute runs) at a constant intensity (70%

HRR).

Two more issues that were addressed were two methodological concerns with O'Halloran's (1994) data collection techniques. In her study, she attempted to capture subjective experiences during the exercise bout (via the FS and RPE) by having the runners stop and complete the questionnaires. By doing so, it is believed that this would break any rhythm established by the runners which could affect their cognitions (i.e., cause them to become irritated). This problem was addressed by having the experimenter run beside the participant and asking her to provide verbal ratings of the FS and RPE from a hand held sign.

Second, O'Halloran also required her participants to carry a micro cassette recorder in their hands and speak into it by holding it to their mouths while they ran (but only carried it for the two five minute sessions). This could be of concern because the runners would not be able to maintain their normal upper body motion (stride)while running which could have been a distraction for them. The present study attempted to limit this by having the participants carry the tape-recorder in a running pouch with a microphone attached to their shirts. This allowed the participants to speak at any time during the run giving them the opportunity to become comfortable with speaking aloud. As will be seen in the next session, this could be of vital importance to validity.

<u>Concurrent Verbal Reports</u>

Thought processes can be described as a sequence of states, each state containing the end products of cognitive processes, such as information retrieved from long-term memory, information perceived and recognized, and information generated by inference.

The information in a state is relatively stable and can thus be input to a verbalization process and reported orally. However, the retrieval and recognition processes delivering the end products and the information to attention can not be reported (Ericsson & Simon, 1993).

The standard method for having participants verbalize their thoughts concurrently is to instruct them to talk or think aloud. However, it is important to note a potential limitation of this technique is that participants verbalizing their thoughts while performing a task (running) do not describe or explain what they are doing--they simply verbalize the information they attend to while generating the thought (Ericsson & Simon, 1993). Therefore, this technique may not be able to obtain thoughts that runners may normally think about while they run.

When participants verbalize directly only thoughts entering their attention as part of performing a task, the sequence of thoughts is not changed by the added instruction to think/talk aloud. However, if participants are also instructed to describe or explain their thoughts, additional thoughts and information have to be accessed to produce these auxiliary descriptions and explanations. As a result, the sequence of thoughts is changed because the participants must attend to information not normally needed to perform the task (Ericsson & Simon, 1993). Thus, the present participants were not asked to describe or explain their thoughts.

Another potential concern is that it can not be forgotten that when an experimenter instructs participants to talk/think aloud, some participants may misunderstand the instructions and produce instead the more common social communication, explaining or describing the process to the experimenter. This is not wanted because social verbalizations may be quite different from the sequence of thoughts generated by the subjects themselves (Ericcson & Simon, 1993). The present study attempted to protect itself from this concern by making sure the participants understood that they were to speak freely about whatever came into their minds while running and various examples were provided to them.

Although using concurrent verbal reports had its disadvantages, it also has its advantages. The most obvious one is it enables one to determine what the participants are thinking about during the exercise bout, whether it be their own natural thoughts or ones generated due to being in the study. This avoids any memory biases which may result from using a retrospective method. Secondly, as Ericcson and Simon (1993) have claimed, for tasks of longer durations(longer than 10 seconds), the validity of concurrent verbal reports is higher than that of retrospective reports.

Design of Study

The design of the study was a 3 (25 minute run, 40 minute run, and a control) x 2 (pre-run mood states versus post-run mood states) between subjects design with repeated measures on the second factor. The number of participants in each condition were 25, 24, and 20 respectively.

Method

Participants

Sixty-nine physically fit female volunteers participated in the present study. Twenty-five participants in a 25 minute run, 24 in a 40 minute run and 20 in a control condition. They were recruited from physical education and campus recreation classes at the University of Alberta, sign-up sheets posted at the Fitness Center (see appendix A) and local running clubs, and the Prince Edward Island Canada Games women's soccer team. In order to be included, the participants had to run at least 20 minutes a session 3 times a week. Following the suggestions of O'Halloran (1994), demographic information included age, weight, running times per week, minutes per run, running distance per week, running experience (years), other exercise, HR rest, and HR exercise. As can be seen from the means presented in Table 1, one way ANOVA's found that participants in all three conditions were not significantly different from each other with respect to running times per week $F(2, 61) = 1.74$, $p>0.05$, minutes per run $F(2,53)= 1.55$, Table 1.

Means and standard deviations of the participants demographic variables.

Effect Mean(sd)	25 minute run	40 minute run	Control
age	26.52 (8.53)	21.54 (5.65)	25.55 (4.47)
weight	127.32 (8.88)	135.04 (9.58)	126.35 (14.34)
running times per week	3.56 (0.71)	3.79 (1.25)	3.20 (0.77)
minutes per run	46.72 (16.99)	40.58 (14.02)	38.93 (10.77)
distance per week	19.91 (10.55)	18.67 (12.36)	12.72 (4.20)
running experience	5.42	6.96	4.87

	(4.24)	(2.65)	(2.26)
number of other activities	7.64	2.00	1.33
	(3.29)	(0.77)	(0.69)
HR rest	55.96	54.52	56.68
	(5.71)	(4.98)	(2.83)
HR exercise	156.44	158.54	
	(6.73)	(9.30)	
Cooper's distance	1.47	1.47	
	(0.19)	(0.14)	
Cooper's classification	3.88	4.00	
	(0.60)	(0.51)	

$p > 0.05$, distance per week $F(2, 57) = 2.28$, $p > 0.05$, running experience $F(2, 60) = 2.25$, $p > 0.05$, number of other activities $F(2, 51) = 0.57$, $p > 0.05$, and resting heart rate $F(2,65) = 1.16$, $p > 0.05$. However, they were significantly different with respect to age $F(2, 66) = 3.86$, $p < 0.05$ and weight $F(2, 65) = 4.25$, $p < 0.05$. Post hoc tests using the joint multivariate bonferroni procedure revealed that the participants in the 40 minute run condition were significantly heavier than the control subjects while the participants in the 40 minute run condition were also significantly younger than the 25 minute and control condition participants. The distance covered by the participants in the two running conditions during the first 12 minutes (Cooper's test described in detail below) of their runs were not significantly different $F(1,47) = 0.01$, $p > 0.05$, neither were their fitness classifications $F(1,47) = 0.57$, $p > 0.05$.

<u>Materials</u>

Mood questionnaires. Two mood questionnaires were administered to the participants: the Feeling Scale (FS: Hardy & Rejeski, 1989) and the Exercise-Induced Feeling Inventory (EFI: Gauvin and Rejeski, 1993). The FS is a one-item questionnaire (see appendix B) that requires the participants to indicate how good or bad their feeling states are at the present moment. The participants select a number on a scale from -5 to +5 with verbal anchors at the odd integers. The concurrent validity of the FS with the Rate of Perceived Exertion Scale (Borg & Noble, 1974) is high ($r=.56$, $p < .00001$) (Rejeski et al., 1995).

The EFI (see appendix C) requires the participants to rate (using a five-point scale) each of 12 adjectives to determine how they feel at that moment in time. The five choices available are 'do not feel', 'feel slightly', 'feel moderately', 'feel strongly', and 'feel very strongly'. The 12 adjectives represent four factors (positive engagement, revitalization, tranquillity, and physical exhaustion) containing three items each. Examples of the items included in each subscale are 'enthusiastic' for positive engagement, 'refreshed' for revitalization, 'calm' for tranquillity, and 'fatigued' for physical exhaustion. Internal consistencies were .87 for revitalization, .91 for physical exhaustion, .82 for tranquillity, and .82 for positive engagement (Gauvin & Rejeski, 1993).

Rate of Perceived Exertion. In addition to the mood questionnaires, Rate of Perceived Exertion (RPE; Borg & Noble, 1974) was collected during the exercise bout(see Appendix D). This measure of how hard participants think they are working has a test-retest reliability of .80 (which means it is consistent in an exercise environment) and correlates with measures of heart rate ($r=.56$ to .68). Individuals reporting lower RPE's tend to have lower heart rates than individuals reporting higher RPE's. As heart rate is related to fitness level, one would expect a fair range of heart rates across a particular RPE when comparing among persons.

Cooper's walk/jog/run test. This test was used as an indication of fitness. It involves running as far as possible in 12 minutes. It is best performed on a track of specified distance which is recorded and compared to a classification table in order to assess aerobic fitness. The five fitness categories are very poor, poor, fair, good, and excellent. These are adjusted for age and gender (Cooper, 1982). In the present study, this test was conducted by recording the distance covered by each participant during the first 12 minutes of their run.

Qualitative measures. A stream-of-consciousness technique developed by James (1890) was used for the purpose of recording thoughts during running. This technique simply requires the participants to talk into a hand-held tape-recorder. The participants must verbalize everything and anything that passes through their minds (Pennebaker, 1989). The present study modified this technique by having participants talk at designated times into a microphone attached to a cassette recorder in a running pouch.

Procedure

Participants were recruited from physical education and recreation classes, campus recreation classes, and sign-up sheets posted in the Fitness Center and local running clubs. Once they were recruited, the participants were contacted by phone and were asked to measure their resting heart-rates three mornings in a row prior to testing. The reason for this was to be able to determine the relative intensity of each participant for her exercise bout (i.e., 70% HRR). These calculations were done by subtracting heart rate max (220 -

participant's age) from heart rate rest. The obtained number was then multiplied by 0.70 (70% HRR) and added to 60.

On the day of the exercise bout, participants were met at an indoor track site and were asked to sign an informed consent (see Appendix E). Next, they were asked to complete the Exercise-Induced Feeling Inventory (EFI) and the Feeling Scale (FS). Once these measurements were completed, the participants who participated in one of the two exercise conditions (a 25 minute run at 70% HRR or a 40 minute run at 70% HRR) were fitted with a heart-rate monitor (Sport Tester Polar Electro mode PE 3000) and a tape-recorder (SONY TCM-77V) in a running pouch with a microphone attached to their shirts. The participants assigned to the 10 minute control condition were not fitted with these instruments. The procedures for the three conditions are outlined below.

<u>25 and 40 minute run conditions</u>

In both exercise conditions, participants were told that they would complete the Cooper's test during the first 12 minutes of their run to assess their fitness level using 70% of their age-predicted heart-rate reserve. When completed, the rest of the running procedure was explained to them and any questions were addressed. Participants started their run after all questions were answered. In the 25 minute run condition, the participants were signaled to talk about anything that came to their minds 9 $^{1/2}$ minutes into the run (37.5%) while they kept running. After talking for 5 minutes, the experimenter ran beside the participants asking them to provide ratings for the FS and RPE scale from a hand-held sign. They were then told that they did not have to speak anymore. Twenty minutes following the start of the run (80%: 5 minutes left), the same procedure was followed. This time, upon completion of the procedure, the participants were instructed to start their cool down (i.e., walk around the track without talking to anybody until their heart rates returned to within 10 beats of their resting heart-rates upon entering the track site). Once this was accomplished, they were asked to complete the EFI and FS. Participants in the 40 minute run condition were signaled to talk about whatever came into their minds fifteen minutes (37.5%) into the run. After talking for five minutes, the participants were asked for their verbal ratings of the FS and RPE scale following the same procedure as above. Thirty-five minutes (87.5%: 5 minutes left) following the start of the run, participants were again signaled to talk into the tape-recorder. Five minutes later, they were asked for their verbal responses to the FS and RPE scale (following the same procedure) and were then instructed to start their cool down. When their heart rates return to within 10 beats of their resting heart rates, they were asked to complete the EFI and FS.

In both exercise conditions, the tape-recorder was turned on for the entire run. This allowed for the participants to speak whenever they wished to do so in order for them to get practice talking aloud. However, it was only the thoughts recorded during the two 5 minute time spans signalled by the experimenter that were used for analysis purposes.

Control Condition

Once the participants completed their baseline measures, they were asked to sit in the bleachers at the track site for 10 minutes (time interval chosen from Rejeski et. al's (1995) study) and observe what was going on around them. The participants then completed the EFI and FS (see appendix F for procedure outline). It was decided to have a control condition at the track site in order to have consistency with the environments (i.e., have all participants at the same track site) and to show that the mood of the participants who did not exercise in the same environment may not improve as much as the participants who did exercise. Therefore, it was the intention of the experimenter to rule out the alternative hypothesis that participants' moods would be enhanced by being in the same exercise environment without exercising.

Valence Ratings

In order to be able to determine the valence ratings of the various thoughts, the tape-recordings were transcribed. Once this was completed, the participants were contacted by phone to provide a valence rating for each thought (i.e., whether the thought was positive, negative, or neutral). This was done within 1 day of the recording so the run would be fresh in the runner's mind in case any transcription errors were made. Furthermore, participants had the option of listening to their tapes in order to correct any errors.

Data reduction and coding

Transcribed data were analysed by breaking down the information into thoughts. A "thought" ended when the subject matter changed. Each "thought" then became a unit of analysis and these units were coded into different categories according to their content (O'Halloran, 1994). An example of a body-relevant thought was, "My left ankle is a bit sore actually;" a body relevant (other) thought example was, "I'm still feeling nice and smooth;" a body non-relevant thought example was, "I'm actually pretty bored at the moment."

When coding for the categories recorded early in the run (9 1/2 or 15 minutes into the run) and later in the run (35 or 40 minutes into the run), frequency counts were taken of the number of thoughts that fit into each category. Once this was completed, the percentage of body-relevant thoughts, body relevant thoughts (other) and body non-relevant thoughts were calculated for each participant. For example, participant A may have had 32% body relevant thoughts, 15% of body relevant (other) and 53% body non-relevant early in the run.

A valence rating for each thought was also coded. The codes were '-1' for a negative thought, '0' for a neutral thought, and '+1' for a positive thought. Participants were asked to give their own valence ratings for each of their thoughts once they had been transcribed. Once this was completed, keeping with the above example for participant A, the percentages of positive, negative and neutral thoughts were calculated for each of the thought categories early in the run. For example, of the 32% of the thoughts which were body-relevant, 50% may have been positive, 25% negative, and 25% neutral. This was done for the remaining two categories as well.

Variables

The independent variable was the treatment condition which had three levels: a) a 25 minute run at 70% HRR, b) a 40 minute run at 70% HRR, and c) a 10 minute control condition. The dependent variables were the Feeling Scale, RPE ratings, and the EFI subscales taken at pre- post-run. Finally, the thought categories obtained during the exercise bouts were used as predictor variables in subsequent regression analyses and dependent variables for frequency comparisons across conditions.

Statistical Analyses

EFI

The first phase of the analyses was to conduct a conservative test of the post-run mood scores (EFI subscales) using an analysis of covariance (ANCOVA) with pre-run scores serving as the covariate. This was done in order to determine if it was the exercise bout itself that influenced mood or if the pre-run mood states strongly influenced the post-run scores. Before these analyses could be carried out, the assumptions of ANCOVA were tested.

In the second phase of analyses, the pre-run (covariate) measure of each subscale was regressed on the post-run measure of each subscale and the residuals were retained for subsequent analyses. This procedure resulted in the removal of variance in the post-run measure associated with the pre-run measure. The F and β values are presented to describe the pre-run to post-run relationship. The residuals were then examined via one way ANOVA's to determine if any differences due to condition (control, 25 minute run, 45 minute run) existed.

A limitation of the preceding analyses is that they do not allow for an assessment of the moderating role of the pre-run measure on the post-run measure. The unstandardized β gives only an indication of the slope of the relationship between the pre-run and post-run measures. As a means of investigating this relationship, phase three involved calculating difference scores (i.e., post-run minus pre-run) for each EFI subscale, and these were correlated to the time 1 measure. If the pre-run measure influences the post-run, there should be a strong correlation between the pre-run measure and the difference between the pre-run and post-run (the difference score) with a negative value of **r** indicating that the lower the pre-run score, the bigger the change, and a positive value of **r** indicating that the lower the pre-run score, the smaller the change. The presence of ceiling and floor effects must be assessed in order to determine whether the relationship is due to limitations in the measure per se. Using the ceiling effect as an example, if all individuals achieving the highest possible score (12) are removed from the analysis, and the correlation holds, then the relationship is not solely due to the "topping out" of scores, or ceiling effects. We can then hypothesize that any relationship present is due to the condition.

RPE and Feeling Scale

In order to determine if the RPE and Feeling Scale ratings were different from early in the run (9 1/2 minutes into the exercise bout of the 25 minute run; 15 minutes into the exercise bout of the 40 minute run) to later in the run (20 minutes into the exercise bout; 35 minutes into the exercise bout) within each condition and whether the 40 minute condition had higher RPE ratings than the 25 minute condition, 2 (condition: 25 minute versus 40 minute) x 2 (time: early versus later) mixed-model MANOVA's were used with repeated measures on the second factor.

To determine if subjective experiences during the run (obtained via FS) and the dosage of exercise (25 or 40 minute run) predicted post-run mood states (obtained via EFI subscales), a forward stepwise regression was done for each of the four subscales of the EFI. The predictor variables for each analysis were the FS rating early in the run, FS rating later in the run, and condition. The criterion variable was the EFI subscale used for the analysis.

Valence

To determine if the percentages of positive, negative, and neutral thoughts were similar across conditions and time for each thought category, 2 (condition) x 2 (time: early versus later in the run) x 3 (valence: positive, negative, or neutral) mixed model MANOVA's were used with repeated measures on the second factor.

Thought Categories

In order to determine if the percentages of each thought category were different from early in the run (9 1/2 minutes into the exercise bout of the 25 minute run; 15 minutes into the exercise bout of the 40 minute run) to later in the run (20 minutes into the exercise bout; 35 minutes into the exercise bout) within each condition and whether the 40 minute condition had higher percentages than the 25 minute condition, 2(condition) x 2 (time: early versus later in the run) x 3 (thought: body relevant, body relevant (other), and body non-relevant) mixed model MANOVA's were used with repeated measures on the second factor.

The purpose of the following analyses was to examine the way the participants were processing information (i.e., cognitions) related to their feeling states and to determine any relationship that may be have been present between a thought category and the valence of that thought. As a rule of thumb in doing regression analyses, 10 participants are needed per variable (Cohen & Cohen, 1983). The present study had 69 participants. Therefore, the regression analyses were done separately for each EFI subscale. Four forward stepwise regressions were conducted using each of the different thought categories as predictor variables and the EFI subscales as criterion variables. For example, the first regression analysis was entered as such: the predicting variables were body-relevant, body relevant (other), and body non-relevant thoughts recorded early and later in the run (total of six variables) and the criterion variable was the chosen mood state (e.g., tranquillity subscale of the EFI). If one of the thought categories early or later in the run accounted for significant variance in the criterion variable, then that thought category and its valence ratings were subjected to a forward stepwise regression (total of 4 variables) to test for the moderator effects of valence. If the addition of the valence variables increased the variance accounted for in the criterion variable, this was considered to demonstrate a moderating effect. If the variance accounted for did not increase, it was considered that a moderator effect was not present. This process was done for each the remaining three EFI subscales as well.

Results

EFI

Positive engagement

ANCOVA. Diagnostics showed that the correlations between the pre-run and post-run scores were high in the control condition (.69), weaker in the 25 minute run conditon (.57), and weaker in the 40 minute run condition (.38). However, the assumption of homogeneity of slopes was not violated $F(2, 62) = 1.83$, $p > 0.05$. The ANCOVA found a main effect for condition $F(2, 64) = 26.33$, $p < 0.001$. Post hoc analyses using the individual univariate confidence interval procedure found that the 40 minute and 25 minute runs (not significantly different from each other) had significantly more positive engagement post-run than the control condition.

Residual Analysis. The regression revealed an R^2_{adj} of .28 for the pre-run value, $F(1, 66) = 26.65$, $p < .001$, unstandardized $\beta = 0.63$ (standardized = 0.54), $t(66) = 5.16$, $p < 0.001$. A one way ANOVA of the residual by condition revealed a main effect for condition $F(2, 65) = 24.62$, $p < 0.001$. Student Newman Keuls (SNK) post hoc tests revealed that the two running conditions had significantly more positive engagment than the control condition while the 25 minute run produced significantly more positive engagement than the 40 minute run.

Difference Scores. As can be seen from Table 2, it can be interpreted from the correlations that the lower the pre-run scores for the 25 minute and 40 minute run conditions, the greater the change that can be expected in positive engagement. This was

Table 2.

Correlations (Pearson's r) of pre-run EFI subscale measures with calculated difference scores for each condition.

Condition	Phy.Ex. Diff	Phy.Ex. Diff-ceiling	Tranq. Diff	Tranq. Diff-ceiling	Revit. Diff	Revit. Diff-ceiling	Pos.En. Diff	Pos.En. Diff-ceiling
Control (n=20)	-.29	-	-.64*	-	-.16	-	-.21	-
25 min. (n=25)	-.84**	-.86** (n=23)	-.71**	-.72** (n=23)	-.78**	-.76** (n=23)	-.67**	-
40 min. (n=24)	-.74**	-	-.54*	-.47* (n=22)	-.59*	-	-.64*	-.72** (n=22)

* p<0.05
** p<0.001

not the case for the control condition. Furthermore, once the ceiling effects were removed from the 40 minute run condition (2 participants ceilinged), the relationship got stronger suggesting a moderating effect of the pre-run positive engagement score for both running conditions.

Revitalization

ANCOVA. Diagnostics showed that the correlations between the pre-run and post-run scores were high for the control condition (.71), weaker in the 25 minute run condition (.56), and weaker in the 40 minute run condition (.11). The assumption of homogeneity of slopes was not violated $F(2, 62) = 1.69$, $p > 0.05$ rendering this analysis appropriate for the subscale. The ANCOVA found a main effect for condition $F(2, 64) = 32.77$, $p < 0.001$. Post hoc tests using the individual univariate confidence interval procedure found that the 25 and 40 minute run conditions (not significantly different from each other) had significantly more revitalization post-run than the control condition.

Residual Analysis. The regression revealed an R^2_{adj} of .22 for the pre-run value, $F(1, 66) = 19.81$, $p < 0.001$, unstandardized $\beta = 0.65$ (standardized =0.48), $t(66) = 4.45$, $p < 0.001$. A one way ANOVA of the residual by condition revealed a main effect for condition $F(2, 65) = 28.45$, $p < 0.001$. SNK post hocs revealed that the 25 and 40 minute run conditions produced significantly more revitalization than the control condition, but were not significantly different from each other.

Difference Scores. From Table 2, it appears that the lower the pre-run score, the greater the change that could be expected for the 25 and 40 minute run conditions, but not for the control condition. When ceiling effects were tested for the 25 minute run condition

(2 participants ceilinged), the correlation was reduced. But, as can be seen, it was not a significant reduction.

Tranquillity

ANCOVA. Diagnostics showed that the correlations between the pre-run and post-run scores were high in the control condition (.85), weaker in the 40 minute run (.61) and weaker in the 25 minute run (.04). The tranquillity scores had heterogeneous slopes $F(2, 62) = 4.48$, $p=.02$ indicating that the rate of change in tranquillity was different for each of the control, 25 minute run , and 40 minute run conditions. As the homogeneity of slopes assumption was violated, this analysis was inappropriate for this subscale. As a means of handling this problem, difference scores were calculated and the procedure previously described was followed.

Residual Analysis. The regression analysis revealed an R^2_{adj} of .25 for the pre-run value, $F(1, 66) = 23.57$, $p < 0.001$, unstandardized $\beta=0.50$ (standardized $=0.51$), $t(66)= 4.86$, $p < 0.001$. A one way ANOVA of the residual by condition revealed a main effect for condition $F(2, 65) = 8.27$, $p < 0.001$. SNK post hocs revealed that the 25 and 40 minute runs produced significantly more tranquillity than the control condition, but not from each other.

Difference Score. From Table 2, it appears that the lower the pre-run scores in all three conditions, the greater the change expected in tranquillity post-run. However, when the participants who ceilinged were removed from the 25 (2 participants ceilinged) and 40 (2 participants ceilinged) minute run conditions, the correlations increased for the 25 minute condition (not significantly) and decreased for the 40 minute run condition (by a larger margin). This suggested that that a larger change in tranquillity could be expected in the 25 minute run condition. Furthermore, the pre-run tranquillity score was a moderator variable in all conditions.

Physical Exhaustion

ANCOVA. Diagnostics showed that the correlations between the pre-run scores and the post-run scores were high in the control condition (.76), weaker in the 40 minute run condition (.09), and weaker in the 25 minute run condition (.07). The assumption of homogeneity of slopes was violated $F(2, 62) = 7.20$, $p=.002$ suggesting that this analysis was inappropriate for this subscale. Again, difference scores were calculated and correlated to the pre-run measure as already discussed.

Residual Analysis. The regression analysis revealed an R^2_{adj} of .09 for the pre-run value, $F(1, 66) = 7.25$, $p < 0.05$, unstandardized $\beta= 0.09$ (standardized = 0.31), $t(66)= 2.69$, $p < 0.05$. A one way ANOVA of the residual by condition produced no significant differences between groups for physical exhaustion $F(2, 65) = .91$, $p > 0.05$.

Difference Scores. Table 2 suggests that the lower the pre-run scores for the 25 and 40 minute run conditions, the greater the change in physical exhaustion that could be expected (not found in the control condition). Although the 25 minute run condition change was larger than the 40 minute run's change, it had ceiling effects present (2 participants). However, testing for the ceiling effects found that the relationship strengthened with the removal of those participants. Therefore, the pre-run physical exhaustion score was a moderator variable for the two running conditions.

RPE and Feeling scale

The 2 (condition) x 2 (time) mixed model MANOVA found no main effect for condition $F(1, 47) = 3.88$, $p > 0.05$, (i.e., RPE's were not significantly different from each other across conditions). However, time was significant $F(1, 47) = 39.88$, $p < 0.001$. Post hoc tests using the joint multivariate bonferonni procedure found that RPE ratings were significantly higher later in the run than earlier in the run. There was no condition by time interaction $F(1,47) = 0.08$, $p > 0.05$.

A 2 (condition) x 2 (time) mixed model MANOVA did not find a main effect for condition $F(1,47) = 0.75$, $p > 0.05$ for the FS (i.e., subjective experiences across the two conditions were not significantly different from each other. However, time was significant $F(1,47) = 20.08$, $p < 0.001$. Post hoc tests using the joint multivariate bonferonni procedure found that subjective experiences later in the run were significantly higher than earlier in the run. There was no condition by time interaction $F(1,47) = 0.21$, $p > 0.05$.

Feeling Scale Regressions (conditions collapsed)

Tranquillity. The regression produced an R^2_{adj} of 0.19 for the later in the run FS value which was significant $F(1, 46) = 11.89$, $p < 0.002$. This suggested that subjective experiences later in the run (collapsed across conditions) predicted post-run tranquillity.

Physical Exhaustion. The regression produced an $R^2_{adj.}$ of 0.10 for the later in the run FS value which was significant $F(1, 46) = 6.02$, $p < 0.05$ suggesting that subjective experiences later in the run predicted post-run physical exhaustion.

Positive Engagement. The regression produced an $R^2_{adj.}$ of 0.08 for the later in the run FS value which was significant $F(1, 46) = 4.87$, $p < 0.05$ which suggested that subjective experiences later in the run predicted post-run positive engagement.

Revitalization. Subjective experiences during the run did not account for any variance with respect to post-run revitalization.

Feeling Scale Regressions for each condition

Tranquillity. A regression analysis in the 25 minute run condition produced an R^2_{adj} of 0.29 which was significant $F(1, 23) = 10.75$, $p < 0.05$ for the later in the run FS value. However, subjective experiences early or later in the run did not predict post-run tranquillity for the 40 minute run.

Physical Exhaustion. A regression analysis in the 25 minute run condition produced an R^2_{adj} of 0.46 for the later in the run FS value which was significant $F(1, 23) = 21.08$, $p < 0.001$. However, subjective experiences early or later in the run did not predict post-run tranquillity for the 40 minute run.

Positive Engagement. A regression analysis done on the 40 minute run condition produced an R^2_{asj} of 0.13 for the early in the run FS value which was significant $F(1, 21) = 4.52$, $p < 0.05$. The 25 minute run regression analysis produced an R^2_{adj} of 0.20 for the later in then run FS value which was significant $F(1, 23) = 7.0$, $p<0.05$.

Revitalization. For the 25 minute run, a regression analysis produced an R^2_{adj} of 0.20 for the later in the run FS value which was significant $F(1, 23) = 6.82$, $p < 0.05$. However, subjective experiences early or later in the run did not predict post-run revitalization.

Valence

Body-relevant thoughts. A 2 (condition) x 2 (time) x 3 (valence) mixed model MANOVA found no main effects for condition $F(1, 47) = 2.90$, $p > 0.05$, valence $F(2, 46)$

= 1.65, $p > 0.05$, or time $F(1, 47) = 0.18$, $p > 0.05$ (i.e., similar percentages of positive, negative, and neutral thoughts were found across conditions and time). Interaction effects were not found for valency by time $F(2, 46) = 0.02$, $p > 0.05$, or valency by time by condition $F(2, 46) = 0.24$ $p > 0.05$. However, there was a significant condition by valence interaction $F(2, 46) = 5.83$, $p < 0.05$. Post hoc tests using the joint multivariate bonferroni procedure found that there were significantly more neutral thoughts in the 25 minute run condition than the 40 minute run condition.

Body-relevant (other) thoughts. A 2 (condition) x 2 (time) x 2 (valence) mixed model MANOVA (there were no neutral valences recorded in this category) found no main effects for condition $F(1,47) = 0.09$, $p > 0.05$, valence $F(1,47) = 0.31$, $p > 0.05$, or time $F(1, 47) = 0.78$, $p > 0.05$ (i.e., similar percentages of positive and negative thoughts were recorded in both conditions and across time). No interaction effects were found for condition by time $F(1, 47) = 0.78$, $p > 0.05$, valence by time $F(1, 47) = 0.10$, $p > 0.05$, or condition by valence by time $F(1,47) = 0.29$, $p > 0.05$.

Body non-relevant thoughts. A 2 (condition) x 2 (time) x 2 (valence) mixed-model MANOVA did not find main effects for condition $F(1, 47) = 1.04$, $p > 0.05$, or time $F(1, 47) = 1.04$, $p > 0.05$. However, valence was significant $F(2,46) = 7.45$, $p < 0.05$. Post hoc tests using the joint multivariate bonferonni procedure found that there were significantly more neutral thoughts than positive and negative ones. No interaction effects were found for condition by valence $F(2, 46) = 1.29$, $p > 0.05$, condition by time $F(1, 47) = 1.04$, $p > 0.05$, valence by time $F(2, 46) = 1.16$, $p > 0.05$, or condition by valence by time $F(2,46) = 1.95$, $p > 0.05$.

Thought Categories

A 2 (condition) x 2 (time) x 3 (thought) mixed model MANOVA found no main effects for condition $F(1, 47) = 0.90$, $p > 0.05$ or time $F(1, 47) = 0.82$, $p > 0.05$. However, thought was significant $F(2, 46) = 52.24$, $p < 0.001$. Post hoc tests using the joint multivariate bonferonni procedure found that there were significantly more body non-relevant thoughts than body-relevant and body-relevant (other) while there were significantly more body-relevant than body-relevant (other) thoughts. No interaction effects were found for condition by thought $F(2, 46) = 1.32$, $p > 0.05$, condition by time $F(1, 47) = 1.82$, $p > 0.05$, thought by time $F(2, 46) = 0.0005$, $p > 0.05$, or condition by thought by time $F(2, 46) = 0.51$, $p > 0.05$.

Thought Categories' Regressions

Tranquillity. The regression analysis revealed an R^2_{adj} of 0.12 for body non-relevant thoughts (later in the run) which was significant $F(1,46)=7.35$, $p < 0.05$. This suggested that body non-relevant thoughts later in a run predicted post-run tranquillity. However, this relationship was not moderated by valence.

Physical Exhaustion. A regression analysis produced an R^2_{adj} of 0.10 for body-relevant thoughts (later in the run) which was significant $F(1,46) = 6.76$, $p < 0.05$. However, valence did not moderate this relationship.

Positive Engagement. No thought categories predicted post-run positive engagement.

Revitalization. No thought categories predicted post-run revitalization.

Discussion

The primary purpose of this study was to fill gaps in the literature on the psychosocial outcomes of exercise. While many physiologically-related theories exist in explaining psychological processes occurring with exercise (e.g., endorphins responsible for runner's high), there is little research examining other psychological variables that may act as moderators. In particular, Rejeski and Thompson (1993) have indicated that the area of cognition and exercise has been neglected. There are only a few studies examining thought processes co-occurring with exercise. Furthermore, it is only recently that researchers have begun to examine the potential impact that these thoughts have on feeling states (Goode & Roth, 1993).

There has also been relatively little research conducted on how the dosage of exercise may influence the impact of various psychological outcomes. As Rejeski et al. (1995) have pointed out, this is important from a public health perspective because "exercise represents a broad rubric that encompasses a variety of positive physiological demands"(p.357). Therefore, the question becomes one of therapeutic prescription. That is, what dosages of exercise are the most beneficial from a psychological standpoint when being used in an intervention in behavioural medicine?

Although the study of cognitions during running and dose-response effects are promising, methodological shortcomings have prevented researchers from drawing strong conclusions (cognition literature: using retrospective data, not recording exercise intensity, using heterogeneous samples, and omitting the use of manipulation checks; dose literature: the measuring of post-exercise mood states being done at different times across studies).

In light of these conceptual and methodological concerns, alternative research methods were presented. Specifically, the purpose of the present study was to examine how ongoing thoughts during exercise affected exercise-induced mood changes and the role that the valence (i.e., negative, neutral, or positive thought) of these thoughts had on these mood states. Furthermore, an attempt was made to determine how the duration of exercise (i.e., dosage) may have affected these ongoing thoughts as well as the mood states.

Dose response issues

In the present study, the duration of exercise was manipulated by having female runners run on an indoor track site for either 25 or 40 minutes. Duration of exercise was found to play a role in post-run positive engagement. The 25 minute run produced significantly more positive engagement post-exercise than the 40 minute run which did not support the previous finding by Rejeski et al. (1995). Although the present author criticised previous studies for measuring post-exercise mood states immediately after an exercise bout, Rejeski et al. (1995) did not. Their participants post-exercise mood states were measured 20 minutes after exercise while the present study's were measured when the participants HR's returned to within 10 beats of what they were upon entering the track site (took approximately 10 minutes). This created a 10 minute difference between studies on rating times. However, the ten minute control condition in the present study as well as Rejeski et al.'s (1995) did not produce significant changes in mood. Therefore, the difference in time intervals may not have been a key factor in why the differences between the two studies were found. Therefore, alternative hypotheses may be of value. One could be that Rejeski et al.'s (1995) participants rode on a bicycle ergometer in a controlled laboratory setting whereas the present study's participants ran on an indoor track in a naturalistic environment. Two points should be raised here. First, the different modalities could have been a reason for the differences found. For example, biking is weight supportive while running is weight bearing which could have produced perceptually different experiences causing one to be perceived harder than the other. The second point to be raised is that the use of a naturalistic environment compared to a controlled laboratory setting could have been a reason for the differences between the studies. For example, cycling in a controlled laboratory setting would control for other extraneous variables which could have affected the participants' moods. However, running in a naturalistic setting may not have led to such control. Therefore, other variables could have been responsible for the participants improvement in mood. In order to eliminate this hypothesis, future studies would have to directly compare an indoor and outdoor environment (exercising at similar intensities) to determine any mood differences which may result.

It was also found that there was a general improvement in mood post-exercise (i.e., tranquillity, positive engagement, and revitalization) regardless of duration. This is an important contribution to the literature because Blanchard, Rodgers, & Taerum (under review) found a general improvement in mood regardless of exercise intensity (within the range of 50%-80% HRR) at constant duration (30 minutes). Therefore, exercise duration and intensity may not be as important as was previously expected with respect to post-exercise mood states. However, there are no studies which have examined how intensity and duration may interact to produce various mood states. For example, one does not know whether it is better to exercise at higher intensities for long or short periods of time or if it is as beneficial to exercise at lower intensities for long or short periods of time. These types of questions may not be appropriately answered by studying intensity and duration separately. Therefore, the above statement is "tentative" at best until such studies can be carried out.

In task feeling states

Another objective of this investigation was to examine the influence of subjective responses during exercise on post-run EFI responses and to see if they were similar across the two running conditions. Rejeski et al. (1995) did not find that various exercise durations led to different positive or negative feelings during the later stages of exercise. However, the present study did find that subjective experiences significantly improved later in the run regardless of condition. However, one can not ignore the environmental and modality differences which could have been responsible for the different findings.

One of the most interesting findings with respect to in-task feeling states was that subjective experiences later in the run predicted post-exercise tranquillity, physical exhaustion, positive engagement, and revitalization for the 25 minute run only. This strongly suggests that subjective experiences during shorter durations of exercise may be more important than in longer durations if the job is to enhance post-exercise mood. However, although subjective experiences later in the run accounted for variance in post-exercise mood states for the 25 minute and not the 40 minute run condition, this could have been due to the fact that: a) there were other potential subjective experiences that the feeling scale did not tap into and b) other thought categories could have could have predicted post-run mood in the 40 minute run condition. One should also not ignore the fact that both running conditions led to significant improvements in mood post-exercise. This may call into question the importance of subjective experiences during exercise as a whole if mood improves regardless of what they are. Furthermore, it leaves questions unanswered with respect to what other variables may be responsible for predicting post-exercise mood in the 40 minute and 25 minute running conditions (e.g., cognitions, endorphins, etc...).

Thought Categories

A key finding with the current study was that the participants (regardless of running condition) had significantly more body non-relevant thoughts than body relevant and body-relevant (other) while there were significantly more body-relevant than body relevant (other). Of key interest was whether these thoughts predicted post-exercise mood states and whether the valence of these thoughts moderated the relationship. In the exploratory phase with these new categories, it was found that body non-relevant thoughts later in the run predicted post-exercise tranquillity while body-relevant thoughts later in the run predicted post-exercise physical exhaustion (valence did not moderate either relationship). The latter relationship would be expected intuitively, but was also in congruence with previous literature (Goode & Roth, 1993) in that associative thought has been correlated to increased fatigue post-exercise. The former relationship may be the more important one of the two because it was associated with a positive mood state. It is common sense that the better one feels post-exercise, the more likely he/she will exercise again. Therefore, if runners can be taught to think about body non-relevant thoughts while they run, it may be an important factor in increasing adherence. Of course, this study is exploring with respect to this question and future studies are needed in order to strengthen any claims that can be made.

Another important finding was that the valence associated with a thought category did not moderate the thought category - post-run mood relationship. Of course, this finding may be relevant because it suggests that it does not matter if what you are thinking about is positve, negative, or neutral while you run, but the type of thought does (i.e., category).

An interesting point that should be addressed is that O'Halloran (1994) did not find that that the type of thought during running had an impact on perceived feeling states post-exercise. However, O'Halloran (1994) had 10 variables with only 11 participants when doing her regressions. This would severely limit her statistical power and hence the validity of the test which could be a reason why similar results were not found between studies.

A second point is that O'Halloran claimed that her thought categories were conceptually distinct, but arguably they were not as one thought could fit into more than one category resulting in shared variance among them. This raises the concern of multicollinearity which occurs when there are moderate to high correlations among the predictors (Stevens, 1996), in this case, the thought categories. As Steven's (1996) suggests, multicollinearity makes determining the importance of a given predictor difficult because the effects of the predictors are confounded due to the correlations among them.

As well, multicollinearity increases the variances of the regression coefficients. The greater these variances, he argues, the more unstable the prediction equation will be. Therefore, O'Halloran's regression equations most likely encountered such problems making it difficult to support her predictions.

Concurrent Verbal Reports

As mentioned earlier, there were potential concerns about using concurrent verbal reports. Although using them makes the present study's methodology much stronger than if retrospective data were used, one can not ignore the fact that this method may have inherent problems. First, the idea of talking out loud affected some participants. Examples of their cognitions were "I wonder if this guy thinks I'm a real nutter...." or, "I'm a bit hesitant to talk in front of other people...I'll be okay...there is only a couple of people on the track." These cognitions demonstrated that being in this study may have made the runners feel uncomfortable while they ran. If this were true, then their typical cognitions during their running session may have been altered and their typical cognitions and mood may not have emerged.

The next general area of concern was the environment in which the participants ran. Many of them mentioned the fact that they did not like running inside. Examples of these types of cognitions were, "It sure is different running inside," "... I couldn't imagine running indoors the whole time...I like to be outdoors...," or "It will be nice to get outside again and breath some fresh air in...." Obviously, these participants were distracted or disliked the fact that they were running indoors which may have altered their cognitions. However, the fact that they did not like running indoors was expressed as a cognition along with many others. Obviously, these cognitions raise the question of the context (i.e., the running environment). The participant's cognitions could have been altered by the fact that they were running inside (in more of a controlled setting) rather than outside (in an uncontrolled setting) which suggests that the setting should be taken into consideration when doing such a study. Logically, the next step would be to compare cognitions in an indoor environment to an outdoor environment to determine if the context affects the type of cognitions.

The final potential concern that surfaced in the participants' cognitions were problems with their pace. Many of them disliked the fact that their pace was controlled. For example, one person said, "I really want to speed up so that I will feel I did a good work-out when I'm done." Another person said, "I keep wanting to pass some of them, but I can't because I have to stay in my target zone." These cognitions seem to represent a meta-thought process about exercise. However, this is not clear. It does support Rejeski's personal comment to Dr. Wendy Rodgers that participants do not produce dose-response mood effects because they are not working hard enough. If participants were not restricted by their pace (which many of them thought about), different cognitions may have surfaced if they had run at their normal pace without this distraction. Future studies will have address this issue by increasing the intensity of exercise to determine if this problem could be diminished and to determine if it made a difference in the frequencies of the thought categories.

It is believed that the above cognitions have provided insight about the method used in the present study. In doing so, the common theme which emerged was one of internal and external validity. From an internal validity standpoint, did the run itself cause the improvement in mood or some other extraneous variables. Of all the threats to internal validity (selection, history, maturation, testing, instrumentation, nonequivalence, regression, and mortality), selection and history were the only ones of potential concern. However, Smith and Glass (1987) suggest that history can be controlled for by using a control group. The present study used a control group to rule out the alternative hypothesis that mood would be enhanced regardless of exercise at the track site. Of course, this was disproven as only those participants who exercised show a marked increase in mood over time. Therefore, the present study seemed to have history under control. With respect to selection, age and weight were significantly different across conditions. In an attempt to rule out these potential confounds, age and weight were correlated to the post-run EFI subscales and the FS scores early and later in the run. As can be seen from Table 3, all the correlations were small and insignificant. This

Table 3.

Correlations of age and weight with the FS and post-run EFI subscales.

	FS(early)	FS (later)	Pos. En.	Revit.	Tranq.	Phy. Ex.
Age	0.15 n.s.	-0.12 n.s.	0.05 n.s.	0.05 n.s.	0.03 n.s.	0.04 n.s
Weight	-0.03 n.s.	-0.07 n.s.	-0.13 n.s.	-0.04 n.s.	0.09 n.s.	-0.08 n.s.

suggested that age and weight were not of concern when interpreting the results. Therefore, internal validity appeared to be under control.

Now, from an external validity standpoint, do the results of the present study generalize across persons, settings, and times (i.e., does the indoor running environment generalize to a free-exercise environment outdoors?). Cook and Campbell (1979) have pointed out three threats to external validity. The first one is interaction of selection and treatment (i.e., generalizability across persons). Although the author recognizes that volunteer samples may not be representative of the general population, they were not simply university students as the majority of studies are. The present study's sample included many non-students from local running clubs. This definitely increases the external validity of the study. The second violation deals with the interaction of history and treatment (i.e. generalizability across times). The present study ran the participants at all times of the day within both conditions. Finally, the last threat the authors mentioned was the interaction of setting and treatment (i.e., generalizability across settings). This is the issue that was addressed above and that is unknown. However, with good internal validity and fairly good external validity (2 out or 3), the present study's findings seem to allow for "tentative" plausible inferences. One must not forget that many runners do run in an indoor environment. Therefore, the results would probably generalize more so to this environment than the outdoor.

Summary

In regard to the present study conducted, many of the conceptual and methodological limitations highlighted in the review were addressed. First, in-task data were used instead of retrospective data. Second, the categories that the present study used were conceptually driven rather than data driven. I do recognize that these categories are in their initial stages, and that claims made are "tentative" at best. Third, a heart-rate monitor was used with each participant in order to ensure the intensity level was maintained by the runners. The data also insured that the participant sample was homogeneous (with the exception of age and weight) with regards to exercise experience and fitness level. Although the author realizes that the cognitive components (findings) of the study are tentative, significant findings were introduced with respect to the dose-response literature.

Future Directions

The present study found that the 25 minute run produced significantly more positive engagement post-exercise than the 40 minute run. It as also found that there was a general improvement in mood post-exercise (i.e., tranquillity, positive engagement, and revitalization) regardless of duration. Subjective experiences significantly improved later in the run regardless of condition. However, they only predicted post-run mood states for the 25 minute run only. The participants had significantly more body non-relevant thoughts than body relevant and body-relevant (other) while there were significantly more body-relevant than body relevant (other) regardless of condition. Body non-relevant thoughts later in the run predicted post-exercise tranquillity while body-relevant thoughts later in the run predicted post-exercise physical exhaustion (valence did not moderate either relationship).

Despite the relevant findings of the present study, questions remain unanswered. For example, were the participant's cognitions altered by the fact that they were running inside (in more of a controlled setting) rather than outside (in an uncontrolled setting)? This could be tested by comparing cognitions in an indoor environment to an outdoor environment to determine if the context affected the frequency and type of cognitions. Furthermore, it is unclear as to whether similar cognitions would emerge between runners whose pace is considered slow compared to those who are worked at a higher intensity. Finally, it has yet to be determined whether various modalities at similar durations and intensities produce similar cognitions and mood states.

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Appendix A

Sign-up Sheet

Runners Wanted!

Chris Blanchard and Dr. Wendy Rodgers are carrying out a study designed to examine the relationship between cognitions during running (favourable/unfavourable) and mood. Specifically, the study asks you to do some running, answer a brief mood questionnaire, and speak into a tape-recorder about your thoughts throughout the activity. This session will be scheduled at your convenience. A fitness test will be done during the first 12 minutes of your running session to determine your fitness level. After the exercise condition, you will be contacted by phone to provide ratings of the thought s recorded during your exercise session (i.e., if they were positive or negative). This should take approximately 15 minutes.

In order to be able to participate, you must run at least 3 times a week for a minimum of 8 to 10 miles. If you are interested in participating, please leave your name and phone number below or contact Chris directly at 492-7424.

Name	Phone Number

Appendix B

Feeling Scale

Place a number in the blank line next to the question using the following scale:

Very Bad		Fairly Bad		Bad	Neutral	Good	Fairly Good		Very Good	
-5	-4	-3	-2	-1	0	1	2	3	4	5

How good or bad are you feeling right now? _______

Appendix C

Exercise-Induced Feeling Inventory

Please read each item and then mark the appropriate answer in the space next to the word. Indicate to what extent you feel this way right now, that is, at the present moment. Use the following scale to record your answers

1 = do not feel
2 = feel slightly
3 = feel moderately
4 = feel strongly
5 = feel very strongly

_____ 1. Refreshed

_____ 2. Calm

_____ 3. Fatigued

_____ 4. Enthusiastic

_____ 5. Relaxed

_____ 6. Energetic

_____ 7. Happy

_____ 8. Tired

_____ 9. Revived

_____ 10. Peaceful

_____ 11. Worn-out

_____ 12. Upbeat

Appendix D

RPE Scale

Provide a number of how hard you are working right now.

6

7 Very, Very Light

8

9 Very Light

10

11 Fairly Light

12

13 Somewhat Light

14

15 Hard

16

17 Very hard

18

19 Very, Very Hard

Appendix E

Consent Form

Project Title: Exploring the Effects of Cognitions ,Valence and Duration on Post-exercise Mood

Principal Investigators: Chris Blanchard & Dr. Wendy Rodgers

The project is designed to examine the relationship between cognitions during running (favourable/unfavourable) and mood. Specifically, you will be asked to do some running, answer various mood questionnaires, and speak into a tape-recorder about your thoughts throughout the activity. This session will be scheduled at your convenience. A fitness test will be done during the first 12 minutes of your sessin to determine your fitness level. After the exercise condition, you will be contacted by phone to provide ratings of the thought s recorded during your exercise session (i.e., if they were positive or negative). This should take approximately 15 minutes.

Every effort will be made to conduct the test in such a way as to minimize discomfort and risk. However, the required physical activity may induce temporary symptoms of dizziness, nausea, lightheadedness, muscle soreness, and in very rare cases, heart attacks. Every precaution will be taken to minimize these occurrences.

All scores and results will be published in such a way as to protect your identity. The results of the study will not be released in any form in which individuals may be identified. You are also free to discontinue participation at any time.

If you agree to participate, please fill out the bottom portion of this form. If you have any questions regarding the project, we can be reached at the following numbers:

Chris Blanchard (492-7424) and Dr. Wendy Rodgers (492-2677)

I have read the paragraphs explaining the nature and procedures of the study conducted by Chris Blanchard under the supervision of Dr. Wendy Rodgers and I hereby consent to participate in the above mentioned study realizing that I am free to discontinue participation at any time.

Signature ________________

Date ___________________ Witness _________________

Appendix F

Procedure Outline

Prior to the first session, all participants will be required to measure their resting heart rates three mornings in a row in order to be able to adjust the intensity level relative to each participant.

25 minute run session:

Fill out the consent form

Pre-test measures: Fill out the EFI and FS

Fit participant with sport-tester

Take resting heart rate

Procedure explained

Experimental procedure(in minutes):

Time 0: Participants began to run

Time $9^{1/2}$: Participants asked to speak into the tape-recorder while running.

Time 12: Coopers' test completed and distance recorded.

Time $14^{1/2}$: Participants verbally respond to the FS and RPE scale held by the experimenter running along side.

Time 20: Participants asked to speak into the tape-recorder while running.

Time 25: Participants verbally respond to the FS and RPE scale held by the experimenter running along side. They were then instructed to start their cool down.

Time ?: When participants heart rates returned to within 10 beats of their resting heart rates upon entering the track site, they were asked to complete the EFI and FS and were then debriefed.

Day after run: Participant's thoughts transcribed and they were contacted by phone to provide a valence rating for each thought.

40 minute run session:

Fill out the consent form

Pre-test measures: same as 25 minute condition

Experimental Procedures(in minutes):

Time 0: Participants began running.

Time 12: Cooper's test completed and distance recorded.

Time 15: Participants asked to speak into the tape-recorder while running.

Time 20: Participants verbally respond to the FS and RPE scale held by the experimenter running along side.

Time 35: Participants asked to speak into the tape-recorder while running.

Time 40: Participants asked to respond verbally to the FS and RPE scale held by the experimenter running along side. They are then instructed to start their cool down.

Time?: When participants heart rates returned to within 10 beats of their resting heart rates upon entering the track site, they completed the EFI and FS.

Day after run: Participant's thoughts transcribed and were contacted by phone to provide valence ratings for each of their thoughts.

Control Condition:

Participants filled out the informed consent.

Pre-condition measures: Filled out the EFI and FS.

Condition: Observed what was happening at the track site for 10 minutes.

Post-condition: Filled out the EFI and FS.

Given debriefing.

Appendix G

Debriefing

Thank you once again for participating in the present study. As was mentioned in the in the informed consent and sign-up sheets, the purpose of the study was to examine the relationship between cognitions during running and mood.

With respect to the relationship between congnitions and mood, you were asked to speak into the microphone while running so the experimenter could record your thoughts and categorize them into different categoreis. The purpose of this was to determine what types of thoughts during running would produce more favourable moods during and after exercise.

You had to fill out the Exercise Induced Feeling Inventory before and after your exercise bout so the experimenter could determine if what you thought during exercise actually changed your mood (as well as the exercise bout itself). You provided verbal ratings for the Feeling Scale in an attempt to measure how your were feeling during the exercise bout itself. The Rating of Perceived Exertion was recorded to determine how hard you perceived yourself to be working during your exercise bout.

The reason you had to measrue your resting heart rate was so that the experimenter could calculate the intensity level (i.e., 70% heart rate reserve) relative your fitness level for your exercise bout. The Cooper's test was done during the first 12 minutes of your run to validate your fitness level.

The present study manipulated duration of exercise at constant intensity (70% HRR) using 25 and 40 minute runs to determine which dose of exercise would have more beneficial affects on mood as well as on the thought categories (i.e., did one duration produce more favourable thoughts than the other).

For those of you who participated in the control condition, you were asked to observe what was going on at the track site for ten minutes to determine if your mood would change even though you did not exercise. If it did not, then this would provide evidence that the exercise bout was responsible for change in mood.

Once again, thank you for participating and feel free to contact Dr. Rodgers or Chris Blanchard if you are interested in obtaining the results.