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Exploring the effects of thoughts and thought processes on exercise-induced feeling states

Ann-Merie O'Halloran

A Thesis

in

the Special

Individualized

Programme

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ABSTRACT

Exploring the effects of thoughts and thought processes on exercise-induced feeling states

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Concordia University, 1994

The purpose of this research was to explore the effects of thoughts and thought processes on feeling-state changes associated with acute exercise. To achieve this end, two different non-traditional methodologies were adopted. In Study I, the moderating role of ongoing thoughts about mood and emotional intelligence was examined through the use of the State Meta-Mood and Trait Meta-Mood Scales (Mayer & Gaschke, 1988; Salovey et al, 1992) in a laboratory experiment. State meta-mood cognitions were measured during exercise and mood was measured pre and post exercise. Emotional intelligence was assessed following testing. Results indicated that although state meta-mood and trait meta-mood variables did not have a direct relationship with exercise-induced mood variables, selected trait meta-mood variables played a moderating role in the effects of acute exercise on mood. Specifically, individuals who payed attention to their mood and were able to repair mood experienced higher levels of energy post exercise than pre exercise in comparison to individuals who were less capable of repairing moods.

In order to probe further the thoughts of subjects during exercise, a different conceptually-based approach was used in Study II. The concept of levels of thinking (Pennebaker et al., 1990) which investigates *what* individuals are thinking about during acute exercise and *how* they are processing this information was employed along with an alternative methodology, namely the Stream of Consciousness methodology (Pennebaker et al, 1990).

Thoughts were recorded during exercise, whereas responses to mood questionnaires were taken pre and post exercise. Following coding of qualitative responses during running, hierarchical multiple regressions for repeated measures (Pedhazur, 1982) were conducted. The results indicated that thinking about inner thoughts and feelings, problem solving, and body monitoring was related to differing levels of thinking. In a second regression analysis, level of thinking was found to play a moderating role on the Feeling Scale, Tranquility and Positive Engagement, indicating that more positive feeling states at pre-exercise were related to higher levels of thinking during exercise, but higher levels of thinking during exercise were related to similar levels of mood at post exercise. These results are not overwhelming; however, they warrant further replication and extension.

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For Granny.....

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General Introduction

Since the fitness boom of the early seventies, researchers have been exploring the impact of exercise on psychological well-being. It was not until the last decade, however, that this research was recognized not only as scientifically meaningful, but important practically (c.f. Folkins & Sime, 1981) This observation is made through the proliferation of the quality and quantity of papers presented at scientific congresses (Association for the Advancement of Applied Sport Psychology, North American Society for the Psychology of Sport and Physical Activity, American Psychological Association, Canadian Society for Psychomotor Learning and Sport Psychology & Society for Behavioral Medicine), published articles (Journal of Sport and Exercise Psychology, The Sport Psychologist, Health Psychology, & Journal of Behavioral Medicine) and books (most recently Exercise Psychology: The influence of physical exercise on psychological processes, P. Sereganian, 1993). Although many issues have yet to be explored, researchers have made significant headway in addressing the questions relevant to exercise. It has been established that exercise is related to positive psychological outcomes including enhanced well-being, the alleviation of depression and the alleviation of anxiety. The practical relevance of the research has been demonstrated through the use of exercise in conjunction with psychotherapy in clinical populations and the use of exercise as treatment for mild non-clinical depression (The mind of the runner: Cognitive strategies used during running, Sachs, 1984).

While much attention has been paid to examining the effects of exercise on well-being, few researchers have examined the role of individual difference variables which may play a part in the perception of feeling states. These intervening variables include self-efficacy, self-esteem, motivation, and cognitions (Rejeski & Thompson, 1993). Researchers

are recognizing the importance of such variables. Beyond accounting for the direct impact of individual difference variables on feeling states, researchers could also turn their attention toward the possible **moderating** role that these variables may play (Baron & Kenny, 1986). This approach may lead to useful insights as has been shown in other areas of research (e.g. Stern, McCants & Pettine, 1982) where the moderating role of changing life events on severity of illnesses has been demonstrated.

Purpose and Objectives of the Dissertation

One variable that is gaining interest in the literature is ongoing thoughts during exercise. Although researchers have long been fascinated by the concept of cognitive processes and their impact on sport performance, only recently have investigators argued that ongoing thoughts during exercise may have an impact on feeling-state changes accompanying exercise (Goode & Roth, 1993). In light of these recent developments in the literature, the focus of this dissertation is twofold. First, a comprehensive review of the relevant literature will be conducted. This review has two objectives: to identify gaps in the literature exploring the impact of exercise on psychological outcomes and to develop a rationale for the use of new conceptual frameworks and alternative research strategies. The second purpose of the dissertation is to apply two of these alternative research strategies to the understanding of exercise-induced feeling states. These strategies include meta-mood and emotional intelligence (Mayer & Gaschke, 1988) and levels of thinking (Pennebaker, 1989). Subsequently, a general conclusion will be drawn from the results of the research reports.

Sources and Methods

To overcome some of the limitations in the methodologies used by past researchers,

methodologies from the realm of social psychology are explored and utilized. For instance, in contrast to past research on thoughts during exercise that has relied on retrospective data, the studies presented use alternative research methodologies in which in-task response data were collected allowing for the conceptual exploration of the moderating roles of these concepts on subsequent feeling states without the contaminating influence of memory biases. However, when drawing conclusions, it must be borne in mind that in-task responses containing subject expectancies and answer biases may play a contaminating role.

Organization of the Dissertation

This dissertation is divided into three major sections. First, a comprehensive review of the pertinent literature entitled *Looking beyond direct relationships: The role of intervening variables* is presented. In order to meet the objectives stated earlier, previously-conducted research is critiqued. Specifically, the review of literature identifies studies that have examined the impact of thoughts on sport performance. This portion also serves as an historical overview tracing the origins of research on the impact of thoughts during exercise on feeling states. Within each study, conceptual and methodological concerns are highlighted. Subsequently, possible alternative research strategies are reviewed. A rationale for the use of these strategies is also presented.

The second section consists of a research report: *The effects of acute exercise on mood: On the moderating role of ongoing thoughts and emotional intelligence.* This study applies one of the two alternative research strategies. On one hand, meta-mood cognitions, developed by Mayer and Gaschke (1988), is defined as thoughts which individuals entertain about ongoing mood. On the other hand, meta-mood abilities is defined as the ability to self-

regulate mood. Direct relationships between meta-mood cognitions and meta-mood abilities and exercise-induced changes in feeling states were studied through a laboratory experiment. In addition to examining the direct relationships, it is also important to examine the moderating roles which meta-mood cognitions and meta-mood abilities may play in the perception of feeling states.

The third section of this dissertation entitled *Exploring the moderating effects of level of thinking on mood changes associated with acute exercise in female runners* will employ the concept of level of thinking as well as methodologies developed by Pennebaker (1989). Level of thinking is defined as the degree of self-awareness, self-reflection and introspection within people's thoughts. Similar to meta-mood cognitions, level of thinking has yet to be applied to exercise-related research. This research was conducted as a field experiment where exercise-induced thoughts and feelings were measured and analyzed.

Subsequently, a general conclusion is presented summarizing the major findings as well as tying together the predominant concepts used. In addition, suggestions for future studies are presented. The appendices include all the questionnaires that were used in the reported research.

This dissertation is not written in the traditional format. Following the recommendations of Thomas, Nelson, and Magill (1986), the format is a series of articles. The purpose is for "a more rapid publication of quality research" (Thomas et al., 1986, p. 116). Although redundancies may emerge, it is hoped that the advantages of disseminating the information in an expedient fashion will compensate for the repetitiveness.

Relevance of Research

Over the past 15 years, exercise has become a more widely practiced lifestyle behavior. While the physiological benefits have been documented, researchers have paid less attention to the psychological processes. In the studies that have been done, researchers acknowledge the presence of individual difference variables and suggest them as the subject of future research. Empirical studies on this most important topic are long over-due.

The following research uses past research reports as a stepping-stone in attempting to develop a more complete understanding of the aspects of exercise-induced mood. Specifically, the research uses previously identified exercise-induced feeling states to examine the variables which may play a role in moderating these states. By identifying moderating variables which affect mood favorably, practical applications of this research include better exercise prescription and the enhancement of the motivation of exercise participants.

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Looking Beyond Direct Relationships: The Role of Intervening Variables

Introduction

The literature on the effects of exercise on well-being is growing exponentially. Specifically, various meta-analyses and substantial reviews of literature have been conducted 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, there is a dearth of research investigating the role of moderating variables which may influence the direction and magnitude of mood changes This is unfortunate because a significant portion of the variance remains unaccounted for in the research on psychological states and exercise. Researchers have begun examining the impact of various physical activities and differing intensities of these activities (Rejeski, 1994), but further information is required to paint a more complete picture of how and when psychological effects of exercise on feeling states can be expected.

The purpose of this review is two-fold: To identify gaps in the extant literature exploring the impact of exercise on psychological outcomes and to develop a rationale for the use of new conceptual frameworks and alternative research strategies. These purposes will be achieved by presenting an overview of the existing literature as well as offering a summary of selected alternative research methodologies.

Although many issues are yet to be explored, researchers have made significant headway in identifying psychological outcomes of exercise. Specifically, evidence exists to support the effects of exercise on the alleviation of depression, the anxiety reducing effects of exercise, exercise and the enhancement of self-esteem and of self-efficacy (McAuley, 1994; Rejeski & Thompson, 1993) as well as the energy augmenting properties of exercise. A

summary of what is known in these areas is presented below.

Exercise and the Alleviation of Depression

An area of research which has gained attention in recent years is the impact of exercise on depression. Exercise has become an adjunct to pharmacological therapy because of its ease of administration and lower cost (Sachs & Buffone, 1984). Through the manipulation of various types of exercise (e g. running or biking, aerobic or anaerobic) and duration of exercise (varieties of lengths of single bouts or lengths of exercise programmes), researchers have examined whether activity results in changes in depression. To address the question of the efficacy of exercise in decreasing depression, North, McCullagh, and Tran, (1990) conducted a meta-analysis on 80 studies and 290 effect sizes. The studies included in this analysis were an aggregate of published and unpublished studies, clinical and non-clinical populations, and acute and non-acute exercise bouts In fact, the only criteria for inclusion were that the study had an exercise-related outcome measure for depression and that the study had to be published prior to 1989 The researchers found that aerobic exercise, most commonly walk-jog or running programmes, was a more effective anti-depressant than non-aerobic forms of exercise such as weight training (ES -1.78, p< .001) They also found that the longer the length of the exercise programme, the greater the anti-depressant effect. Interestingly, decreases in depression in those exercising were equal for males and females across all age groups.

A more recent narrative review of literature (Byrne & Byrne, 1993) yielded the same conclusion in regard to the anti-depressant effects of exercise. The authors, however, identified some methodological shortcomings. For example, Byrne and Byrne (1993)

suggested that research instruments may be sensitive enough to detect changes in clinical populations, but not in non-clinical individuals, leading to an underestimation of the studied phenomenon. In addition, they stated that many exercise programmes are not explained in enough detail to either provide comparisons or be replicated, therefore limiting the generalizability of the results.

In a position paper compiled following the 1992 International Consensus Conference in Toronto, Morgan (1994) also concluded that exercise is associated with the alleviation of mild to moderate depression, but that severe depression necessitates professional treatment with exercise as complementary. This conclusion parallels a previous consensus statement drawn by a panel of experts at the Centers for Disease Control (Morgan & Goldston, 1987).

In summary, in spite of methodological problems including lack of definitions, inadequate sensitivity of research instruments, and the absence of reported detail for the purpose of replicability, decreases in depression are consistently observed to be associated with exercise. Unfortunately, much of these same methodological problems exist in examining other psychosocial outcome, in particular, exercise and anxiety reduction. Specifically, Thayer (1978, 1986) has done extensive work to demonstrate that psychological outcomes may lie on more than one dimension, thus offering further support in identifying the methodological problems cited above.

Exercise and the Reduction of Anxiety

A second area of research which has experienced much growth is exercise and its anxiety-reducing effects. In a 1991 meta-analysis, Petruzzello and his colleagues found that anxiety is reduced with exercise regardless of the measurement instrument used to assess

anxiety. For this meta-analysis, the criteria for inclusion were: Adequate detail provided to calculate effect sizes and subjects not "interacting with experiment-imposed psychological stressors" (p.146). The analysis of 104 studies revealed that aerobic exercise is related to reduced state and trait anxiety. Greater effect sizes were found when the exercise was 30 minutes or less in duration (Rejeski & Thompson, 1993). When pooling the results for the meta-analysis, the effects observed in some studies using a 20-minute minimum requirement were masked by studies using an alternative treatment control group Other forms of treatments such as relaxation, however, were found to be as effective. A subsequent review of literature, performed by Landers and Petruzzello (1994) revealed similar results to the 1991 meta-analysis. The authors found that physically fit subjects demonstrated less anxiety than less fit individuals. These differences in anxiety levels were associated more with aerobic-type exercise independent of intensity and duration of exercise.

In sum, lack of methodological rigor has prevented review authors from drawing definite conclusions based on the research. These concerns include lack of control groups and ceiling and floor effects due to the use of non-clinical subjects. Nonetheless, support has been found for the alleviation of anxiety and depression through exercise. Moreover, the research has not examined negative relationships between exercise and psychosocial outcomes Positive psychological outcomes include self-esteem and self-efficacy, presented next

Exercise and the Enhancement of Self-Esteem and Psychological Well-Being

A third area which has elicited research interest deals with the effects of exercise on mental-health outcomes. While mental health is multi-faceted, it encompasses general psychological outcomes such as mood and self-concept. In a landmark review of the

literature Folkins and Sime (1981) found most of the literature to be atheoretical. The authors, highly critical in drawing conclusions, nonetheless found that physical fitness training was related to improved mood, self-concept and work behavior (Folkins & Sime, 1981, p. 373) A subsequent narrative review (LaFontaine, DiLorenzo, Frensch, Stucky-Ropps, Bargman, & McDonald, 1992) identified well-controlled experimental studies. Although these authors' intent was to focus on mood and exercise, the studies cited only measured degrees of anxiety and depression associated with exercise. However, mood enhancement, does not necessarily occur in the absence of anxiety and depression, or more generally, negative symptomology (McAuley, 1994).

In a recent review (McAuley, 1994), only 23 studies were found where well being was measured as a study outcome and research instruments measured something other than negative symptomology It must be noted that subjects in these reviews were considered non-clinical. McAuley (1994) also found some support for the positive relationship between positive affect and physical activity, but lack of adequate and sensitive research instruments precluded the author from drawing general conclusions. However, it should be noted that Thayer (1989) and Gauvin and Rejeski (1993) have found that levels of energy increase post exercise, a dimension not considered by McAuley (1994).

It is perhaps more appropriate to examine the literature on self-esteem and self-efficacy. McAuley (1994) has defined self-esteem as "encompassing the favorable views one holds regarding one's self" (p.551). In a summary of the meta-analyses and reviews that have been done on self-esteem and exercise, McAuley notes that although the results are not particularly convincing, 60% of the studies did demonstrate increased self-esteem with

physical activity. However, methodological problems included ceiling and floor effects in the measurement instruments. The results are also conceptually limiting since the measurement of self-esteem is a multi-dimensional supposition.

In sum, recommendations put forth by Folkins and Sime (1981) and Lafontaine and his colleagues (1992) reflect that there is a need to identify more theoretically based research framework as well as to identify individual differences which may cloud our understanding of the phenomenon. Additionally, it must be underscored that positive psychological outcome variables are not necessarily observed in the absence of negative outcomes. Thayer (1986) contends that positive mood states occur on a different continuum than negative mood states

Summary

Two conclusions can be drawn from the extant literature: First, the research lacks rigorous scientific control resulting from inadequate methodologies and research instruments Many studies included in the above mentioned meta-analyses and reviews of literature investigated both anxiety and depression simultaneously. This purpose is achieved through the use of various research instruments such as the Profile of Mood States and the Beck Depression Inventory (Rape, 1987). It must be noted that there are various clinical disorders which are regrouped under the general terms 'depression' and 'anxiety', including unipolar and bipolar depression as well as trait anxiety and full blown phobias. While Morgan's (1994) review distinguished mild to moderate depression from severe depression, many researchers do not include the severity of depression and anxiety in their reports

It cannot be concluded that the impact of exercise on depression and anxiety is a simple direct causal relationship. Landers and Petruzzello (1994) indicated in their review

that exercise intensities and durations are not often presented in research reports. However, the degrees and types of depression and anxiety vary as well as the intensity, duration and types of exercise. With all the variability involved in examining and comparing studies, it is most difficult to attribute causal relationships.

Second, very little work has focused on potential intervening variables despite their apparent relevance. While there is a huge amount of literature on the psychological outcomes of exercise, there is a dearth of research examining variables which may potentially have a mediating or moderating effect on the results. Researchers use a simple stimulus, in this case, exercise, and examine the response, psychological outcomes. In rare cases, the impact of intervening variables is examined.

Baron and Kenny (1986) have recommended examining variables which may have mediating or moderating effects on outcomes. On one hand, a moderator variable is a variable that "affects the relationship between the independent and dependent variable" (p.1174). A mediator variable, on the other hand, is a variable that "intervenes between the stimulus and the response" (p.1176). Some intervening variables include gender and age differences (e.g. Lafontaine et al., 1992), self-perception, self-esteem, physical fitness status, social cognition and subjective perceptions.

Unfortunately, researchers have used the terms mediator and moderator interchangeably in examining intervening variables (Baron & Kenny, 1986). Although it is beyond the scope of this paper to classify variables as moderating or mediating, an identification of intervening variables is nonetheless appropriate.

Cognitions and Exercise: A Gap in the Exercise Psychology Literature

In their review of the history of exercise psychology, Rejeski and Thompson (1993) state that the literature can be separated into topic areas including among others, fitness and mental health. Rejeski and Thompson indicated that the area of cognition and exercise has been neglected. This gap in the research and, more importantly, the relevance of examining cognitions in relation to the mental-health benefits of exercise impelled me to pursue this line of research. That is, looking at the possible moderating role of cognitions during exercise is useful in developing a complete picture of the state of exercise-induced mood research.

Thus, the next section of this review will involve three steps. First, I will present a history of the study of cognitions in physical activity research. Second, I will review specific studies examining the effects of thought processes on sport performance. Third, I will critically review investigations of thought processes on psychological outcomes and make arguments for the research to be carried out.

Historical Overview

While many physiologically-related theories exist in explaining psychological processes occurring with exercise, (e.g. endorphins responsible for the runner's high or the thermogenic models used to explain decreases in anxiety and depression), there is little research examining other psychological variables that may act as moderators Specifically, 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 in identifying cognitive strategies adopted by elite marathon runners.

Association-Dissociation Model

Morgan and Pollack (1977) proposed that what runners focus on during a marathon has an impact on t'.eir running time. In their research, these authors conducted in-depth interviews with twenty American elite marathon runners Here they distinguished between dissociative and associative modes of thought. Dissociative thinking can be defined as thinking about anything other than the somatic perceptions arising from physical adaptation to exercise. For instance, Morgan (1978) reported that some individuals pretend they are listening to music. Other dissociative techniques include solving a complex mathematical problem or going through the processes of building a house from the foundation to the roof. Associative thinking occurs when athletes focus on physiological processes such as breathing, muscle cramps, and heart rate. Morgan (1978) also stated that these runners use "the same cognitive strategy for coping with pain and discomfort" (p.39).

Morgan expected the elite marathon runners to report dissociative thoughts during running, if not more elaborate fantasy-like thinking. It became apparent while conducting these interviews that these elite athletes did use dissociative cognitive techniques some of the time, but tended to switch back and forth between dissociative and associative. The marathoners reported that they had to pay attention to their bodies at least some of the time to monitor energy reserves and breathing rates However, when faced with pain, these athletes would dissociate in order to cope. Morgan concluded that dissociation is good in some instances if applied cautiously. For example, a runner in this study used a dissociation technique when getting through the 'Heartbreak Hill' portion of the Boston Marathon. He would imagine himself in the front of his father's locomotive engine and imagine his legs as

the pistons of the engine. However, more associative techniques were required when running great distances to monitor the body for dehydration, muscle cramps, or energy reserves. Morgan (1978) also reported that these runners adopted a dissociative cognitive strategy when doing training runs because of the slower pace

From a Two-Factor to a Three-Factor Model

As Morgan's work gained attention, other researchers attempted to refine and improve the association-dissociation model of cognitive strategies. Sachs (1984) made the definitions of association and dissociation more precise. Although left unexplored by Morgan (1978), Sachs proposed that not all runners use the same cognitive strategies when dissociating While investigating the 'runner's high' phenomenon, Sachs defined association as mainly a 'left-brain' activity because of its analytical nature. In addition, he deemed dissociation as seeming to be either 'left-' or 'right-brain'. An example of a 'left-brain' strategy is solving a mathematical problem whereas enjoying music is an example of a 'right-brain' activity (Sachs, 1984, p. 291).

Sachs proposed that 'right-brain' activity would be conducive to 'runner's high' and, therefore, a better perceived run. In order to test this hypothesis, Sachs interviewed 60 runners. He 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 (p.291). These runners were then randomly assigned to three cognitive strategy groups. The first group, the associators, was asked to use association techniques by concentrating on their body sensations, analysis of stride, and rate of respiration. The second

group, the 'left-brain' dissociators, were instructed to either solve a personal problem or to count objects they saw along the route of their run, either mailboxes or cars. The last group, the 'right-brain' dissociators, were asked to think of music without words or to paint a mental picture of their friend or spouse (p.301). The runners were then asked to use their assigned cognitive strategy when running the second last mile of their run.

Although Sachs did not succeed in finding any performance differences, he subsequently offered various explanations. He found that using experienced runners was difficult because they have already determined which cognitive strategy works best for them. Asking these runners to adopt a strategy other than their own may have been intrusive, as reported by one of the study participants Sachs' suggested that the use of associative and dissociative strategies must be further explored and the approach should be carefully planned so as to overcome some of the resistances offered by the study participants.

The Impact of Thought Processes on 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 The latter researchers attempted to investigate the effects of cognitive strategies on the perception of effort through the association/dissociation model. In this study, 44 subjects were assigned to each of four treatment groups. The first, the control group was not given any instruction on what to focus. The second, the association group, was told that the purpose of the study was to report physiological processes. This included focusing on breathing and tension. The third, the internal dissociators group, was asked to recall every teacher's name since kindergarten. The fourth group, the external

dissociators, were engaged in conversation with two research assistants. All subjects cycled on a cycle ergometer at 60% of their VO_2 max for 15 minutes. Following the exercise, subjects were asked to report their Rate of Perceived Exertion (RPE, Borg & Noble, 1974) during the exercise.

The results of the group asked to associate had higher RPE 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. In other words, when subjects were asked to monitor their physiological processes, they perceived their effort as greater than those who performed internal dissociation. No differences were found between the external dissociation group and the control group. The authors explain that the control group subjects, not instructed in how to think, may have been using some kind of dissociation technique. The authors suggest that future research should examine the role of gender differences as well as using quantitative means to measure information processing. Unfortunately, these authors do not suggest how this might be achieved.

Further Refinement of the Model

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. Pennebaker and Lightner (1980) have used internal cues for association and external environmental cues for dissociation. In their study, these researchers asked 57 male students to listen to different sounds on a walkman while walking at a constant rate on a treadmill. In the first session, subjects walked for ten minutes without any sounds being emitted from the walkman they

were wearing. In the next session, subjects were randomly assigned to each of three conditions: street sounds, the sound of their own breathing or nothing. Self-report measures of fatigue and other bodily symptoms were taken periodically. The results indicate that subjects who listened to the street sounds reported less fatigue and other symptoms than the subject who did not hear anything. On the other hand, subjects who listened to their amplified breathing reported significantly more fatigue. Physiological measures such as heart rate and blood pressure did not differ significantly between the conditions

Similar results were found in a subsequent study (Pennebaker & Lightner, 1980) where 13 subjects were asked to run on a track and on a cross-country trail on alternate days over a ten-day period. Both the track and the trail were the same distance. It was hypothesized that there would be more fatigue reported on the track because it lends itself to a focus on internal stimuli. The trail, however, forces the runner to pay attention to the environment. Therefore, less fatigue should be reported. Despite the fact that the results did not support this hypothesis, an interesting outcome surfaced. The running times for the same distances were significantly different. Specifically, the running times for the trail were lower than those for the track despite the fact that the nature of the terrain would lead us to believe that the time would be slower. Although the subject observed the same fatigue levels, the work done was greater for the trail than the track as reflected through the times.

Caution must be exercised when drawing conclusions with regards to these two studies. The authors did not attempt to measure thoughts during either the treadmill or the jogging study. In the treadmill study, the control condition could have elicited internal or external focus. The street sounds most probably elicited the external focus because of the

novelty. For the breathing condition, since it is repetitive, the subjects could have 'tuned out' after a while. In addition it is relatively safe to say that the subjects running on the cross country trail were using external environmental cues because they had to be vigilant of rocks and other potential hazards. However, when running on the track, subjects could have potentially been using either internal or external focus or a combination. Manipulation checks, in this case, should have been performed.

Morgan and Pollack (1977) 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. Internal dissociation implies cognitive strategies such as listening to imaginary music, writing imaginary letters or solving hypothetical problems. External focus implies paying attention to environmental cues. The definitions of associative thinking remained the same. From the above-mentioned studies, it appears that dissociative and external focus have been more successful for non-elite athletes.

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 subjects to fill out a questionnaire while cycling. This provided an external distraction which could be verified. Subjects were asked to pedal at a comfortable rate and intensity. Twenty subjects were randomly assigned to each of two conditions: associative and external focus. Members of the associative group were asked to focus on their heart rate and leg muscles while the

external focus group was required to fill out a questionnaire on body image. Each group cycled for 30 minutes. On a different day, the groups were reversed. The associative group did the questionnaire and the external focus group did the associative thinking. As a form of manipulation check, the participants were actually 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 that 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, an attempt was made at using subjects with a more uniform and comparable fitness level, something not considered in previous studies. All subjects participated in the control condition where they were instructed to run at a normal pace, the dissociation condition where subjects were asked to imagine themselves sitting on a beach or solving a mathematical problem, (instructions taken from Weinberg, Smith, Jackson, & Gould, 1984) and external focus, where they were asked to count the number of hurdles on the track and the number of cars on the road. For the manipulation check, subjects were asked to report what they were thinking of. Dissociation thinkers reported singing songs, writing letters and thinking of a variety of pleasant things. 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. 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 is probably a recommended cognitive strategy for tasks requiring endurance such as cycling or running .

Quantifying Cognitive Strategies

In an attempt to quantify associative and dissociative cognitive techniques, Schomer (1986) devised a study in which he recorded associative and dissociative thinking by having subjects talk into a cassette recorder while running. This methodology was a considerable improvement over any previous studies in that it eliminated the inherent problems of retrospective data. Schomer asked subjects to talk continuously into a cassette recorder while on a training run. The subject pool covered the spectrum of novice to elite marathon runners. These individuals were asked to participate in several sessions of which the first two were familiarization sessions. After each training run had been completed, the subjects filled out the Rate of Perceived Exertion Scale (Borg & Nobel, 1974). In total, 62 recordings ranging from 45 to 120 minutes were retained for analysis. Unfortunately, not enough data is reported in order to determine the number of sessions each subject participated in

Schomer (1986) attempted to place the recorded thoughts of his subjects into ten categories. These categories included *feelings and affect*, where the thoughts described bodily feelings such as 'I feel fine". *Body monitoring*, the second category, contained thoughts concerning physiological processes such as breathing rate. The third category comprised thoughts concerning *command and instruction*, for instance, thoughts about slowing down or relaxing the upper body. *Pace monitoring*, the fourth category, contained

thoughts on the general progression of the training run. Examples included "only a little bit to go". The fifth category, *environmental feedback*, contained thoughts concerning the environment such as car fumes and the temperature. The sixth category contained *reflective activity thoughts*. These were "thoughts on past and future issues on running" (Schomer, 1986, p.46). Examples of these thoughts were upcoming scheduled races or feelings about past races. The seventh category was comprised of thoughts relating to *personal problem solving*. For this category, examples would include wondering what one's spouse/significant other is doing at the moment. The eighth category, *work, career, and management* contained thoughts concerning work or home chores to be done. The ninth category was comprised of thoughts on *course information* such as scenery or the placement of other runners. The last category contained *talk and conversational chatter* with other runners. Schomer reported that the categories of *feelings and affect, body monitoring, command and instruction* and *pace monitoring* consisted of the 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 classifies 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, there is no evidence that these concepts are related to the perception of effort. According to Schomer,

pace monitoring reflected a narrow external focus of attention. In addition, a broad internal attentional style, which is also dissociative, were comprised of *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, the categories themselves are somewhat disputable in their descriptions. For example, Schomer (1986) identifies the categories of *body monitoring* and *command and instructions* as distinct. An examination of the examples given for *command and instructions* reveals that this category should be included under *body monitoring.* For instance, a runner telling himself to breathe deeply exhibits a form of body monitoring. In addition, the category of *reflective activity thought* is included in dissociative thinking. Examples used in the category description reveal that some thoughts may be associative in nature. To illustrate, "I remember the way I struggled up this hill" is associative because body monitoring is involved in assessing a struggle. Struggling up a hill implies shortness of breath, muscle soreness, and/or increased heart rate, which are all physiological processes. Thinking about these implies an associative cognitive strategy.

Following the categorization of each thought, an analysis of variance was conducted on the associative thought categories to see if there were differences between the novice, average, and elite runners. The results were non-significant, indicating that the groups statistically used the same amounts of associative strategies.

The results do not support Morgan and Pollack's (1977) work stating that elite marathon runners use more associative techniques than their non-elite counterparts. In addition, similarly to Johnson and Seigal's (1992) findings, a positive relationship was found

between associative cognitive techniques and rates of perceived exertion. In other words, the more the subjects thought associatively, the higher their rate of perceived exertion. However, in Schomer's study, there was no mention of any measure of heart rate or maximal oxygen capacity. There is no indication of the intensity level at which the subjects were working. It is well known that the Rate of Perceived Exertion Scale (RPE, Borg & Noble, 1974) varies with heart rate and/or exercise intensity. Therefore, it is 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. Although, as mentioned, Schomer's (1986) use of moment-by-moment data is a considerable methodological improvement over Morgan and Pollack's (1977) retrospective data, the categories for thoughts and the interpretation of results are questionable.

In a subsequent study, Schomer (1987) attempted to teach runners to think in an associative manner. The subject sample in this case included four novice runners, 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 thinking and discouraged dissociative thinking. Runners were then asked to complete the RPE (Borg & Nobel, 1974) following each session. The results indicate that eight of the ten subjects progressed toward the more associative thinking. Along with this progression, Schomer noted an increase in perceived effort, which is congruent with earlier work reviewed here.

There are, however, methodological concerns that do not coincide with definitions of

associative and dissociative strategies. For example, the trainers' communications with the runners offered the runners a dissociative outlet for their thoughts. Verbalizing thoughts when someone is simultaneously listening may not be conducive to saying exactly what is on one's mind. Monitoring moment-by-moment thoughts amounts to a much greater degree of invasion than in Sachs's (1984) study. Schomer also proposed that runners could learn to categorize their thoughts and determine if they are associative or dissociative when trainers are not available. By reflecting and analyzing thoughts, subjects are somewhat removing themselves from the thought. This process can be considered a form of dissociation since time spent actively categorizing thought is time not spent on pure association.

Further, Schomer (1987) reported that, as the association strategies were adopted, training intensities rose. This direct relationship can be attributed to many factors. For instance, the author does not indicate at what level the runners worked during their training runs, which differ from the pace at which a marathon is run. The subject sample was so diverse that uniform training intensities cannot be assumed. In addition, it is possible that only the fact that someone was offering a distraction in an otherwise wearisome training regimen could have produced the effects (i.e. Hawthorne effect). Therefore, it can be summarized that mental training professionals should exercise caution when considering the manipulation of thought processes.

The Impact of Thought Processes on Psychological Outcomes

In contrast to the work on thought processes and performance, Goode and Roth (1993) proposed that there is a relationship between thoughts during running and feeling states. These researchers attempted to quantify thoughts during running by devising a

questionnaire: The Thoughts During Running Scale (TDRS). Their purpose was two-fold. First, they wanted to investigate which cognitive strategy was employed most frequently and second, they explored the possible connection between cognitive strategy and mood. Developed using interview data, the 32-item questionnaire was then administered to 533 university students who reported that they sometimes walked or ran for exercise. A factor analysis yielded a five-factor structure indicating that thoughts during running could be regrouped in the following categories: *associative, external surroundings, interpersonal relationships, daily events,* and *spiritual reflection.*

In a follow-up study, the Profile of Mood States (POMS, McNair, Lorr, & Droppleman, 1971) was administered to 150 male and female experienced runners at the beginning of an individual training run. The subjects then continued into their training and were administered the TDRS and the POMS when they were finished. The results indicate that decreases in tension were associated with thinking about *interpersonal relationships.* Increases in the vigor subscale of the POMS were related to *external surroundings, interpersonal relationships,* and *daily events.* Associative thinking was related to increases in fatigue whereas *interpersonal relationships* and *daily events* were related to decreases in fatigue. The authors suggested that more research is needed to replicate their findings and to produce a more elaborate structure than the five-factor model.

Summary

In sum, there has been much work on associative and dissociative thoughts during running. This research has progressed from the simple two-category association and dissociation model to a multi-factor model. However, it is only the definition of dissociative

thinking that has been refined. Originally, Morgan and Pollack (1977) defined dissociative thinking as anything that was not associative. 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) have regrouped *interpersonal relationships, daily events* and *spiritual reflection* under dissociation. While each author's definition of dissociative thinking has merit, it excludes other possibly important thoughts. Though the definition of associative thinking has remained constant in every study reviewed largely as a result of having been ignored. Thus, more attention should be brought to definitions of both associative and dissociative thinking by examining diverse research strategies in order to develop uniform operational definitions.

Alternative Research Strategies and Theoretical Frameworks

Through the above review, it has been established that thoughts may play a moderating role not only in performance, but more importantly, in the perception of mood. As discussed, the studies are not based on sound theoretical frameworks. There is a wealth of theoretical models and methodologies stemming from the social psychology literature which can be and has been applied to exercise and sport. Examples of these include goal setting (Weinberg, Bruya, & Jackson, 1990), group dynamics (Brawley, Caron & Widmeyer, 1993) and self-efficacy theory (McAuley, 1994). Since these theories, as well as others, have been successfully applied to the realm of sport and exercise, examining alternative methodologies and theoretical frameworks would seem to be a viable strategy. The following sections will describe two emerging areas of research: Emotional Intelligence (Mayer &

Salovey, 1993) and Levels of Thinking (Pennebaker, 1989). These areas offer theory-driven research that can be used in the examination of the impact of thought processes on mood. In addition to offering conceptually-based frameworks, these research strategies were chosen over others because of their appropriateness to exercise settings.

Meta-Mood Processes

While studying patients with alexithymia, a psychological condition in which individuals are unable to recognize or label emotions, Salovey and Mayer (1990) hypothesized that this disorder may be an individual difference variable present to some extent in everyone. Additionally, the researchers stated that the "experience of mood is broader than its emotional content alone" (Mayer, Salovey, Gomberg-Kaufman & Blainey, 1991). While most researchers administer straight mood questionnaires, there are individual differences which go beyond the straight mood experience. To illustrate the possibility of individual differences, Mayer and his colleagues (1991) presented 172 university students with 32 emotional and non-emotional situations. Subjects were asked to react to these situations by ticking off one of twelve possible answers. Through a factorial analysis, the researchers demonstrated that the management of emotion is also relevant to the mood experience in that individuals may want to take action in a particular situation, suppress the emotions, or even deny the emotion experienced with the situation. However, the researchers state that a two-factor model, i.e. emotion related experience and emotion management related experience, although straightforward, is used at the expense of other less clear facets of mood experience.

In an attempt to investigate the influences of mood on thoughts, Salovey and Birnbaum (1989) recruited university students who were experiencing flu symptoms. These

researchers hypothesized that students who were sick would report more symptoms if induced to feel sad than those students who were induced to feel happy. Results indicated that, as hypothesized, the students who were induced to feel sad reported more flu symptoms than those induced to feel happy. In addition, subjects who were made to feel sad were less likely to believe that they would be successful in engaging in health-benefit behaviors. When the same procedure was administered to healthy subjects, the ones made to feel happy, as opposed to neutral or sad, reported that they would be less likely to experience poor health in the future.

Through this study the researchers claimed to shed light on the possibility of thoughts having an effect on mood. The differences noted in perceived ability to avoid future health problems in the happy and sad conditions reflect a mood dependent attentional focus (Salovey & Birnbaum, 1989, p. 548). Salovey and Mayer (1990) have identified these differences as emotional intelligence.

The study of emotional intelligence (Mayer et al., 1991) offers one method for examining the ways in which moods are recognized, controlled and experienced. Salovey and Mayer (1990) have defined emotional intelligence as the "ability to monitor one's own and other's emotions, to discriminate among them and to use the information to guide one's own thinking and actions" (p.189). Meta-mood cognitions refer to thoughts about ongoing mood.

Salovey and Mayer (1990) have suggested that meta-mood cognitions can be categorized according to the extent to which their content reflects *clarity, liking*, and the *management* of present mood. Thoughts that are high in *clarity* would indicate how precisely a person can identify and label current mood. Thoughts that are high in *liking* of the mood

indicate that the individual perceives ongoing mood as appealing or pleasant. Thoughts relevant to mood *management* refers to whether a person is trying to change the ongoing mood. It is important to note that these thoughts go beyond the actual feeling states or moods that are experienced and refer to the person's ongoing thoughts about mood (Salovey, Mayer, Goldman, Turvey, & Palfai, 1991).

Emotional intelligence can be measured through the Trait Meta-Mood Scale (TMMS, Salovey et al., 1991). The TMMS includes 48 items which require the subject to rate on a five-point scale their agreement with the statement in each item. Confirmatory factor analysis indicates that the items have three underlying factors: *attention* to feelings, *clarity* of feelings, and mood *maintenance/repair*.

In order to demonstrate the Trait Meta-Mood Scale's utility, Salovey and his colleagues (1991) showed a group of 78 students a twelve-minute film on drunk driving. This film contained graphic sequences of car accidents and hospital situations. A battery of questionnaires were administered to the viewers at the end of the film. The various subscales on the Trait Meta-Mood Scales were useful in predicting the quality of thoughts and mood. For example, *clarity* was related to positive feelings and low troublesome thoughts following the film. In turn, mood *management* was related to *clarity* in that the clearer the feelings, the more the subjects were able to stop any troublesome thoughts. *Attention* was not related to any of the measures of thoughts and feelings. The authors suggest that subjects were not instructed to pay attention to their feelings, thus warranting further investigation.

Whereas emotional intelligence can be measured through the Trait Meta-Mood Scale, Mayer and Gaschke (1988) devised a questionnaire in order to measure meta-mood

cognitions which occur and are changing. One hundred and sixty university students were recruited to answer the State Meta-Mood Scale, a 60-item questionnaire formulated through earlier research confirming at least a two-factor structure. A five-factor structure emerged from the factor analysis of the State Meta-Mood Scale including *control, clarity, stability, typicality* and *acceptance*. The authors found a five-factor structure to be more inclusive than the two-factor structure cited earlier.

In sum, it is plausible that meta-mood cognitions and/or meta-mood abilities may play a moderating role in the perception of feeling states following exercise because it has been documented that acute exercise is associated with acute mood changes. However, since the questionnaires employed in studying thoughts during exercise do not capture the essence of the thoughts as they occur, perhaps a more qualitative research methodology involving an examination of actual thoughts would be useful in answering additional research questions.

Levels of Thinking

In his book, The Principles of Psychology, William James (1890) defined the five characteristics of thought. Among these, he stated that "every thought tends to be a part of a personal consciousness, and within each personal consciousness, thought is always changing" (p.225). Following these premises, James labelled these ongoing thoughts as *stream of thought*. Klinger (1975), however, called the phenomenon, *consciousness flow*. Pennebaker, (1989) took the concept one step further, by labelling it *stream of consciousness* and proposing that there are various levels on which this steam of thought occurs. Pennebaker, Czajka, Cropanzano, Richards, Brumbelow, Ferrara, Thompson, and Thyssen (1990) proposed that these levels may vary according to emotional or physical states.

Level of thinking, according to Pennebaker (1989), is a viable methodology in assessing the flow of thoughts. The methodology is rather simplistic in that subjects are asked to either speak into a microphone or write on paper, everything and anything that goes through their head at that particular moment. Using the level of thinking methodology, a coding scheme was devised for the determination of the levels of thinking. This scheme is on a continuum from one to five. One indicates low level thinking, where the subject is unconcerned with any emotional or self-reflective thoughts. In an example given by Pennebaker, the subject is commenting on the color of the floor and how it matches her shoes, as well as fact that she has to do her laundry. Level five thinking entails highly self-introspective thoughts. For instance, a subject was struggling with the problem of her parents not accepting the fact that she was now 18 years old and capable of independence. In the latter example, the subject has many more references to herself, as measured through her use of pronouns (I, me, my), and her thinking has an emotional component.

After reading the transcripts of 12 subjects who had recently suffered major trauma in the form of a death in the family, marital breakup, or unemployment, Pennebaker observed three facets of change in thinking during stress. First, under stressful conditions, thinking became more focused in that individuals thought about the 'now' and not antecedent or subsequent implications. Second, their thinking was less self-reflective as observed by the decreased use of pronouns. In other words, subjects were less concerned with the causes and effects of their actions. Third, during periods of stress, subjects were "less aware of emotions or transient changes of mood" (Pennebaker, 1989, p. 330).

To quantify these observations, Pennebaker and his colleagues (1990) devised an

experiment to induce stress and then to observe changes in the levels of thinking. Thirty-two undergraduate psychology students acted as subjects in this experiment. Pre-test measures of level of thinking were taken as the subjects entered the lab. In this first facet of the experiment, subjects were required to sit and write their thoughts for five minutes. The research assistant then escorted them to one of two conditions. In condition one, individuals were subjected to a series of loud, high-pitched noise (88 dba, 2700 Hz) at intervals of 1.2 seconds Subjects were asked to write what was on their minds for five minutes and told that they could turn off the noise at their convenience if it bothered them. In the second condition, the same instructions were given except that the noise could not be turned off. The difference between the conditions was that subjects in the first condition had a perceived control over the noise and subjects in the second condition had no control over the noise. All subjects did the level of thinking exercise post noise under the same no-noise condition. The results indicate that the levels of thinking dropped significantly under the no-perceived-control condition. This result indicates that level of thinking is affected by the amount of control the individual has on his or her environment.

In addition to observing the changes of levels of thinking in stressful situations, the researchers (Pennebaker et al., 1990) also attempted to relate the general level of thinking with individuals' health and personality characteristics. To achieve this, 71 students agreed to participate in this study. Due to subject mortality and equipment malfunction, the data for 39 subjects was retained. In the first portion of the study, subjects were required to fill out a battery of questionnaires including the Psychasthenia Scale of the Minnesota Multiphasic Personality Inventory (MMPI, Hathaway & McKinley, 1942) which measures fear and lack

of confidence and the Pennebaker Inventory of Limbic Languidness (PILL, Pennebaker 1982) which measures perceptions of physical symptoms. The number of health-related visits during a semester was also recorded. Pennebaker found level of thinking to be related to measures of negative affect. Specifically, subjects experiencing more negative affect were also found to be extremely high-level thinkers. In addition, those subjects who were categorized as extremely low-level and extremely high-level thinkers were found to have significantly more visits to health professionals and consumed more aspirin and alcohol. Pennebaker concluded that level of thinking is associated to health related behavior in that those subjects on the extreme ends of the thought continuum reported more instances of illness than those who were classified as moderate-level thinkers.

The authors also extrapolated from these findings that low-level and high-level thinking have both beneficial and detrimental consequences. High-level thinking implies self-reflective thinking, suggesting that the individual may be involved in constant conflict. This may cause some stress on the body However, low-level thinking may have some benefits. In the noise experiment, low-level thinkers were able to block out the noise as was demonstrated by the decreased number of negative emotional words. Pennebaker proposes that this may be an adaptive behaviour. Unfortunately, low-level thinking may also prevent individuals from exploring avenues in which to resolve conflict.

An implication of this research is that individuals are able to move from one level of thinking to another depending on their moods and situations. The methodology involved in collecting the data, in this case, presents an alternative method of asking individuals to recall thoughts during a certain activity. By asking subjects directly what they are thinking of at a

particular moment, the validity problems of recollection data are eliminated. Thus, the quality of the research is enhanced.

Relevance to Exercise

While many researchers have attempted to explain mood benefits through biological processes, for example, thermogenic models and endorphins, few have concentrated on examining the psychological processes involved in regulating mood. Morgan (1973) has stated that 33% of the variance in perceived exertion remains unexplained by physiological variables. He suggested that perhaps psychological variables are involved. Although perceived exertion is not mood, the example illustrates that physiological variables alone may not explain mood changes associated with exercise. While some methodologies and measurement instruments are useful in answering certain research questions, researchers are encouraged to utilize alternative methodologies in the investigation of psychological processes during and following exercise (c.f. Gauvin & Brawley, 1993).

It is relevant to raise the question of a link between both exercise and meta-mood cognitions and exercise and level of thinking, since the mood changes associated with acute exercise have been widely documented (e.g. Rejeski & Thompson, 1993). However, little is known concerning what people think about while exercising, or what kind of meta-mood cognitions are ongoing as a result of exercise. In addition to little being known on what people are thinking, even less is known about how people are thinking about this what. Subjects exercising at various intensities may entertain different thoughts about the feeling states which they are experiencing at any given moment. Similarly, subjects with different lifestyles and fitness levels may process thoughts differently. For example, individuals with

high fitness levels have become accustomed to the feeling states induced by exercise. The perception of feeling states may be accentuated in exercise because mood changes occur so abruptly.

Conclusion

The goals of this review were to identify gaps in the literature on psychological outcomes and to propose a rationale for using alternative research strategies in identifying variables which may moderate exercise-induced mood. Among the gaps discovered was a lack of conceptually-driven thought categories. It would appear that the categories utilized emerged from the data instead of being established on a prior theoretical foundation. Similarly, the use of data-driven definitions as opposed to theory-based ones impede definition uniformity, making the results incomparable. Most flagrant is the lack of methodological rigor. Practices such as using retrospective data, not recording exercise intensity, using heterogenous samples, and omitting the use of manipulation checks weaken the value of practical applications that can be drawn from the results. Thus, the rationale for using alternative methods of investigation couched within a sound theoretical framework is that they provide researchers with tools to conduct empirical studies that may uncover relationships between variables. The objectives of the following research are two-fold: The primary objective is to examine the moderating effects of thoughts on exercise-induced mood; the secondary objective is to improve on the indicated shortcomings of previously conducted research.

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The Effects of Acute Exercise on Mood:

On the Moderating Role of Ongoing Thoughts and Emotional Intelligence

Abstract

The purpose of this study was to examine the role of ongoing thoughts about mood and emotional intelligence in moderating the effects of acute exercise on mood. Twenty-four (24) female college students, including 12 physically fit-active and 12 physically unfit-inactive women, participated in two laboratory sessions. Session 1 was an attention control condition wherein each subject was familiarized with the laboratory and procedures. Session 2 required the subject to exercise at 70% of maximum heart-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 (AD-ACL, Thayer, 1978), and the Feeling Scale (FS, Hardy & Rejeski, 1989) while thoughts about ongoing mood were assessed with a modified version of the State Meta-Mood Scale (SMMS, Mayer & Gaschke, 1988). Emotional intelligence was measured with the Trait Meta-Mood Scale (TMMS, Salovey et al., 1992). Results indicated that both emotional intelligence and state meta-mood were related to mood variables in an exercise setting, but the former also played a moderating role on selected mood states. Future directions and methodological concerns are addressed.

The Effects of Acute Exercise on Mood:

On the Moderating Role of Ongoing Thoughts and Emotional Intelligence

Researchers in the field of exercise psychology have investigated the psychological outcomes of acute exercise. The data indicate that acute aerobic exercise is associated with favorable changes in mood, notably decreases in anxiety and depression (North, McCullagh & Tran, 1990; Petruzzello, Landers, Hatfield, Kubitz & Salazar, 1991) and increases in calmness and vigor (Gauvin & Rejeski, 1993; Thayer, 1989). While the literature on the psychological benefits of acute exercise is increasing steadily, there is a dearth of information examining the moderating role of subjective perceptions of the exercise stimulus and thoughts during exercise (c.f. Goode & Roth, 1993; Rejeski, 1994). The study of meta-mood cognitions (i.e. thoughts about ongoing mood) and meta-mood abilities (i.e the ability to self-regulate mood) (Mayer, Salovey, Gomberg-Kaufman & Blainey, 1991) offers one promising avenue of research aimed at examining the ways in which moods are recognized, controlled and experienced during acute exercise. The purpose of this study is to examine the role of ongoing thoughts about mood and emotional intelligence in moderating the effects of acute aerobic exercise on mood.

Ongoing Thoughts About Mood: The study of Meta-Mood Cognitions

In response to a gap in the literature concerning moderators of mood fluctuations, Salovey and Mayer (1990) pioneered the concept of meta-mood cognitions (MMC). MMC relate to present moods and are defined as thoughts about ongoing mood. Salovey and Mayer (1990) hypothesized that MMC can be categorized according to the extent to which their content reflects *clarity* of the present mood, *liking* of the present mood, and the *management* of the

present mood. MMC that are high in *clarity* would indicate how precisely a subject can identify and label current mood. MMC that are high in *liking* of the mood indicate that the subject perceives the ongoing mood as appealing or pleasant. MMC relevant to mood *management* refers to whether the subject is trying to change the ongoing mood. In sum, MMC go beyond the actual feeling states or moods that are experienced and refer to the person's ongoing thoughts about mood.

Mayer and Gaschke (1988) developed a measurement instrument called the State Meta-Mood Scale (SMMS) to assess ongoing thoughts about mood. The SMMS contains 60 items that the subject rates in terms of agreement along four-point scales presenting the choices: disagree, somewhat disagree, somewhat agree, and agree. Although, theoretically, a factor analysis of the sixty items should have yielded three factors (i.e. clarity, liking, and changeability of mood), Mayer and Gaschke (1988) found that the items were best described in terms of a five-factor structure. These factors included *out of control/under control, confusion/clarity, acceptance/rejection, typical/atypical,* and *change/stability*. A typical item on the *control* subscale would be "My feelings are out of control". *Clarity/confusion* measures the accuracy with which the individual can label mood. A sample item of this dimension is "It is hard to tell what my mood is right now". *Acceptance/rejection* is a measure of the extent to which the subjects are allowing themselves to feel a particular mood. "There is nothing wrong with feeling the way I do" is an example of an item on the *acceptance/rejection* scale. The dimension of *typical/atypical* is a measure of usual versus unexpected mood. "I feel this way a lot" is a sample item from this dimension.

The last factor, *change/stability* measures the degree to which mood is constant. An

example of an item is "This mood, too, shall pass". A high score on the *control* scale indicates that the person is overwhelmed by their mood and a low score would indicate that the mood is under their control. The subjects who score highly on *clarity* report that their mood is strong and easily identifiable. Conversely, a low score would indicate confusion. A high score on *acceptance* indicates an acceptance of mood and a lower score refers to reluctancy in experiencing the ongoing mood. Subjects scoring high on the *typicality* scale indicate that they have experienced this mood in the past and that it will go on for an undetermined period of time. A low score indicates that the ongoing mood is unusual and will change soon. A high score on the *change* scale indicates that the subject believes that the ongoing mood will become more favorable whereas a low score indicates that the subject perceives no forthcoming change.

The internal consistencies for the different subscales range from .83 to .97 in a neutral classroom environment. Discriminant validity for the SMMS was established by correlating each of the Meta-Mood scales with the Pleasant/Unpleasant subscale of the Brief Mood Introspection Scale (Mayer, Mamberg, Volanth, 1988). The correlation, corrected for attenuation, was found to be $r=.63$ ($r^2=.40$). This correlation was judged to be sufficient for independence of the two measurement instruments, although there is obviously a need for additional psychometric studies to further establish discriminant and construct validity.

Exercise and Meta-Mood Cognitions: A rationale

Given that both meta-mood cognitions and acute exercise have been found to be related to mood, it seems relevant to raise the question as to whether one of these two variables could moderate the mood-changing effects of the other (see Baron and Kenney,

1986). In this study, I chose to examine whether meta-mood cognitions could moderate the effects of acute aerobic exercise on mood, recognizing that a reverse tack could have been adopted. My rationale rests on Rejeski's (1994) suggestion that research into the effects of exercise on psychological outcomes has not been entrenched in a social psychological framework where the subject is viewed as an active agent in construing affective experience. A full understanding of the effects of exercise on psychological outcomes requires researchers to, in some way, disentangle the effects of subjective perceptions from the effects of the objective exercise stimulus. Perhaps examining the moderating role of meta-mood cognitions will allow us to partially achieve this disentanglement.

One study presents indirect information in relation to MMC. Kenney, Rejeski and Messier (1987) randomly assigned 22 novice runners to either a "distress management training course" or a no treatment control. Both groups of subjects ran for 30-minute periods, 12 times over a four to five week span. Throughout the five weeks, the distress management course group was administered a multi-modal program consisting of three phases: education about exercise and health, coping behaviors, and integrative practice (Kenney, 1985). Specifically, the course taught the subjects to change their negative affect to positive affect as well as scan their body for tension and relieve this tension. In other words, subjects were educated to regulate their feeling states through different cognitive processes and possible behavioral practices. One might surmise that subjects' meta-mood cognitions were changed in this study. Accordingly, findings revealed that the exercise distress management training had a positive impact on subjects' perceived affect and exertion. The treatment group reported more instances of positive affect and significantly lower rates

of perceived exertion than the control group.

The Study of Emotional Intelligence: Meta-Mood Abilities

Another variable which may play a moderating role in the study of the mood-enhancing effects of exercise is meta-mood abilities (MMA). Salovey, Mayer, Goldman, Turvey and Palfai (1992) have suggested that MMA, also termed emotional intelligence, have three underlying components namely *attention*, *clarity*, and *mood maintenance*. *Attention* refers to the extent to which individuals typically observe the mood that they are experiencing. *Clarity* designates a subject's ability to identify and label moods. *Mood management* or *maintenance/repair* refers to the effectiveness with which a person can change their mood.

MMA can be measured through the Trait Meta-Mood Scale (TMMS, Salovey et al., 1992). The TMMS includes 48 items which require the subject to rate on a five-point scale their agreement with the statement in each item. Confirmatory factor analysis revealed that the items had three underlying factors: *attention to feelings*, *clarity of feelings*, and *mood maintenance/repair*. Examples of each subscale include "I don't pay much attention to my feelings", "I am usually very clear about my feelings", and "I try to think good thoughts no matter how badly I feel" respectively. A high score on the *attention* subscale indicates that subjects are thinking about their moods. A high score on *clarity* indicates that the individual is able to label the ongoing mood. Lastly, a high score on the *maintenance/repair* subscale indicates the ability of the person to regulate their mood. The internal consistencies for the subscales were .86, .88, and .82, respectively.

Meta-Mood Abilities, Moods and Exercise: A Rationale

Previous research has revealed that exercise related mood changes are not of equal

magnitude across individuals (Gauvin & Brawley, 1993; Petruzzello et al., 1991). Yet, no moderating variables have been identified. Since people who are high or low in MMA may respond differently to standard mood-inducing stimuli (Salovey et al., 1992), it may be that responses given in mood questionnaires administered during exercise are at least partially a function of MMA. In other words, mood responses may reflect the ability of a subject to perceive, label, and manipulate current mood. Given the theoretical and data-based link between MMA and mood, it seems useful to examine MMA and their relation to the mood-inducing stimulus of exercise.

The Present Study

The purpose of the present study is to examine the role of MMC and MMA in moderating the effects of acute exercise on mood in physically fit and physically unfit female subjects. Female subjects were chosen to participate in this research in order to preserve same-sex experimenter (Rosenthal & Rosnow, 1984). Additionally, it has been reported that women are more sensitive to changes in positive and negative emotions (Larsen & Deiner, 1987).

In order to examine the moderating role of MMC and MMA, a group of fit-active and unfit-inactive women completed the TMMS and participated in two testing sessions. The exercise session consisted of a bout of acute aerobic exercise wheras the attention control condition consisted of reading. Mood responses were examined prior to and following treatment. In the final minutes of experimental and control manipulations, subjects completed a modified version of the SMMS to provide information about their ongoing thoughts about mood. Data were analyzed through hierarchical repeated-measures regression analysis to

allow for appropriate testing of moderating effects.

Methodology

Subjects

The Exercise Behavior Questionnaire (EBQ, Godin, Jobin, & Bouillon, 1986) was administered to twenty-eight (28) potential female subjects recruited from a university setting. On a one-item questionnaire, each subject was required to rate how frequently they exercise A physically active person was defined as someone who reported participating in vigorous aerobic exercise of a duration of 30 minutes, three times per week for at least four months. An physically inactive person was defined as participating in exercise less than once per week over the past four months.

Potential subjects participated in a submaximal indirect VO_2 max estimation procedure, namely the modified Astrand-Rhyming protocol for cycle ergometer. Physically fit subjects were those who scored above the 75th percentile for age- and sex-appropriate norms of the Canadian Standardized test of fitness (1986) for VO_2 max Subjects were categorized as physically unfit if they scored below the 25th percentile of the guidelines Using both the EBQ and the VO_2 max values as selection criteria, twelve (12) physically fit-active and 12 physically unfit-inactive female subjects were invited to participate in the study.[1]

Manipulation checks of the two groups were conducted by performing T-tests on the EBQ, resting and exercise heart rates, RPE, and estimated VO_2 max. The analysis indicated

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[1]The initial subject pool was 28. One subject was discarded because she did not meet the EBQ criterion and a second on the basis of the VO_2max test. Additional data on two fit-active subjects were collected as a precaution against subject mortality but eliminated from the analysis to preserve even cells.

that the groups differed on these measures. A fitness difference was detected indicating that the fit-active group had a higher maximal oxygen uptake than the unfit-inactive group ($t(1,22)$ 6.44 $p<.01$). T-tests conducted on the resting and target heart rate revealed a fitness effect ($t(1,22)=-3.62$, $p<.01$, and $t(1,22)=-3.89$, $p<.01$), further confirming that the groups were different in fitness levels. Results of the analysis of the EBQ were similar in that there was a significant fitness effect ($t(1,22)=5$ 65, $p<.01$), indicating that the fit-active group had a greater frequency of exercise than the unfit-inactive group. Thus, these analyses demonstrate that the two groups were different in their fitness levels and their activity levels as shown in Table 1.

Insert Table 1 about here

Measurement Instruments

Mood questionnaires. Three mood questionnaires were administered to the subjects: the Feeling Scale (FS, Hardy & Rejeski, 1989), the Activation-Deactivation Adjective Check-List (AD-ACL, Thayer, 1978), and the Positive-Affect Negative-Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988). The Feeling Scale (FS, Hardy & Rejeski, 1989) is a one-item questionnaire that requires the subject to indicate how good or bad their feeling state is at the present moment. The subject selects a number on a scale from -5 to +5 with verbal anchors at the odd integers. Although the FS has not been tested for reliability, the concurrent validity with the Rating of Perceived Exertion Scale (RPE, Borg & Noble, 1974) is high ($r=0.56$ $p<.0001$).

The Activation-Deactivation Adjective Check-List (AD-ACL, Thayer, 1986) consists of 20 adjectives to which the subject must rate on a four-point scale how they feel at the moment. The four choices available are 'definitely feel', 'feel somewhat', 'definitely do not feel', and 'I do not know'. The 20 adjectives are representative of four factors including general activation (*energy*), deactivation-sleep (*tiredness*), high activation (*tension*) and general deactivation (*calm*). Examples of items included in each subscale are 'energetic and lively' for *energy*, 'drowsy and tired' for *tiredness*, 'tense and clutched-up' for *tension*, and 'still and at-rest' for *calmness*. The test-retest reliabilities for each subscale were found to be .89 for *energy*, .89 for *tiredness*, .93 for *tension* and .79 for *calmness*.

Finally, the Positive-Affect, Negative-Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988) was used. Similarly to the AD-ACL, the PANAS contains 20 adjectives to which the subject must rate on a five-point scale the intensity with which they are experiencing these feelings. The forced choice answers range from 'slightly or none at all' to 'very much'. The scale provides an indication of positive affect (PA) and negative affect(NA). A test-retest reliability of r=.85 was found for NA and r=.79 for PA after a one-week interval. However, the reliability tended to increase as the time frame lengthened. Internal consistency was calculated to be high, ranging from α=.86 to .90 for PA and α .84 to .87 for NA.

Rate of perceived exertion. In addition to the mood questionnaires, Ratings of Perceived Exertion (RPE, Borg & Noble, 1974) were collected during exercise. This measure of how hard a person thinks they are working has a test-retest reliability of .80 and correlates with measures of heart rate (r= .56 to .68). For example a score of 11 would indicate that the

subject is cycling at a fairly light workload and would correspond to a heart rate of 110 beats per minutes. A score of 17 would indicate a very hard workload and would consequently correspond to a heart rate of 170 beats per minute.

Meta-mood measures. A modified version of the State Meta-Mood Scale (SMMS, Mayer & Gaschke, 1988) was employed to measure MMC. The 60-item questionnaire was reduced to 25 items by taking the five highest loading items from the originally reported factor analysis. Reliability analyses on 134 versions of the shortened questionnaire yielded the following internal consistencies for each of the subscales: α=.63 for control, α=.86 for clarit α .63 for change/stability, α=.41 for acceptance, and α=.51 for typicality. In order to maximize the subscale alphas, the 25- item questionnaire was further reduced to 19 items by eliminating items not contributing to the overall alpha. The new consistency statistics were calculated to be α .72 for the control subscale, α=.86 for clarity, α=.64 for change/stability, α 68 for acceptance, and α=.60 for typicality.

Additionally, the Trait Meta-Mood Scale (TMMS, Salovey et al., 1992) was used to measure MMC. The psychometric qualities of this scale were discussed earlier.

EBQ. The Exercise Behavior Questionnaire (EBQ) (Godin et al., 1986) was administered to twenty-eight (28) potential subjects. The EBQ is a one-item questionnaire on which each subject was required to rate how frequently they have exercised during the past four months. The forced-choice answers are "not at all", "less than once a month", "about once a month", "about 2 or 3 times a month", "about 1 or 2 times per week", "and 3 times a week or more". The EBQ has a two week test-retest reliability coefficient of .64. Concurrent validity with VO_2 max was calculated to be .38 ($p<.0001$).

Maximal oxygen consumption. A submaximal VO_2 test using the modified Astrand-Rhyming protocol for cycle ergometer was administered. Subjects were fitted with a Polar Electro sport tester (model: PE 3000) to monitor their heart rate. All subjects began by pedalling at a frequency of 50 revolutions per minutes using a metronome to keep the pace. Subjects were allowed a one-minute warm-up at 0 kiloponds to ensure proper height of the seat and pedalling frequency. For the first level of the test, the resistance of the bicycle ergometer was set at 0.5 kiloponds. Individuals cycled at this resistance for three minutes Subsequently, heart rates were used to determine the workloads for the following two levels. The total exercise time was 10 minutes. Final heart rates at the highest completed level were used to calculate VO_2 max.

Experimental Manipulations

In the treatment condition, subjects exercised for a period of 30 minutes at 70% of their maximum heart-rate reserve. Heart-rate reserve was calculated by subtracting the age and resting heart rate of the subject from 220. Multiplying this number by .70 and adding the resting heart rate gave the target heart rate of each individual subject As mentioned earlier, heart rate was monitored throughout the testing session using a sport tester. Measures were taken pre exercise (mood questionnaires), 20 minutes into the exercise (meta-mood questionnaires), and 30 minutes post exercise (mood questionnaires).

Procedure

Subjects participated in two different sessions. For Session 1, subjects entered the lab individually and were required to listen to relaxing music for five minutes. The subjects were then asked to answer the EBQ, SMMS, PANAS, AD-ACL, and the FS. The

questions/adjectives were projected on a white wall and the subject answered orally while the tester recorded the answers. The subjects were then asked to look through some magazines for the purpose of the attention control condition. Twenty minutes after they had begun reading, subjects again answered the SMMS, PANAS, AD-ACL, and FS orally. Subjects read for a total time of 30 minutes. The mood and meta-mood questionnaires were again administered in the same manner immediately post reading. A max VO_2 test was conducted at this point and the subjects left the lab upon completion.

The remaining treatment session was scheduled more than five days but not more than eight days after the attention control session and was conducted in a similar fashion. Subjects entered the lab and listened to relaxing music for five minutes. Subjects then completed the SMMS, PANAS, AD-ACL, and the FS orally. Resting heart rate, determined in the attention control session, was used to calculate 70% of heart-rate reserve. Instead of reading as in the first session, the subjects exercised at the designated heart rate on a cycle ergometer (Monark, model 868) at a power rate of between 40 and 60 watts and 60 to 80 revolutions per minute. Heart rate was again monitored through a sport tester. The resistance of the cycle ergometer was either increased or decreased in order to keep the heart rate within five beats of the targeted heart rate. Twenty minutes into the exercise, SMMS and RPE were administered. Subjects exercised for a total time of 30 minutes. The same mood questionnaires were administered 30 minutes post exercise. After the last experimental session, subjects were given the TMMS to complete on their own time.

Data Analysis

A hierarchical regression analysis for repeated measures (Pedhazur, 1982; Michela,

1990) was conducted on each of the seven mood variables (FS, 4 scales of the AD-ACL, and 2 subscales of the PANAS) using a subjects (24) X Measurement time (4) design. The predicting variables were entered in blocks in the following order. Between subject effects were removed first by entering the trait meta-mood scores to test their contribution to mood scores. Fitness level was entered second to see if any group differences emerged Fitness level was dummy coded with '1' representing fit-active and '0' referring to unfit-inactive subjects. A series of dummy variables designed to fully identify subjects were entered third to remove any residual between-subject variance from the data set. Within-subject effects were removed by entering the five meta-mood scales as a block at the fourth step At the fifth step, pre-test mood scores were entered to remove initial pre-test differences. Experimental effects were removed by entering them in the following order: A condition dummy code was created representing comparison between the exercise and the attention-control conditions. These were entered as a block at the sixth step. A dummy-code vector differentiating between measurements taken pre and post exercise was created and entered at the seventh step. Interaction terms of condition by time, condition by group, time by group, and time by condition by group comprised steps eight through eleven. All between subject, within subject and experimental effects were entered, removing all the variability due to these factors. Moderator effects were then tested for significance. Steps twelve and thirteen were interaction terms created by the interaction of the SMMS subscales and time as well as the TMMS subscales and time (Michela, 1990). The final regression model was as follows:

$$Y = b_0 + [b_1\text{attention} + b_2\text{clarity} + b_3\text{repair}] + b_4G + [b_5S1 + \ldots + b_{28}S23] + [b_{29}\text{control} +$$

b_{30}clarity + b_{31}stability + b_{32}acceptance + b_{33}typicality] + b_{34}PT + b_{35}C + b_{36}T + b_{37}C*T + b_{38}C*G + b_{39}T*G + b_{40}C*T*G + [b_{41}control*T + b_{42}clarity*T + b_{43}stability*T + b_{44}acceptance*T + b_{45}typicality*T] + [b_{46}attention*T + b_{47}clarity*T + b_{48}repair*T].

where G is fitness group, S is subject, C is condition, T is time, and PT refers to mood pre-test scores. There is a possibility that the items on the SMMS and the TMMS are highly correlated thus creating multicollinearity in the regression analysis. However, for this data set, correlations between the items ranged from r=.09 to r=.69. These correlations fell well below r=.85, a criteria for multicollinearity (Deikhoff, 1992).

Results

Each of the mood subscales was analyzed via its own regression model. However, for the purpose of comparison, the results for each predictor are reported in parallel.

Trait Meta-Mood Variables

The results of regression analyses are presented in Table 2. The first block of variables, Trait Meta-Mood Scales, were significant at the point of entry for the FS (R^2=.260, F(3,93)=10.78 p<.00001), both the PA (R^2=.135, F(3,92)=4.78, p<.004) and the NA (R^2=.338 F(3,93)=15.67, p<.00001) subscales of the PANAS and the Energy (R^2=.081, F(3,93)=2.71, p<.05) and Tension (R^2=.196, F(3,92)=7.46, p<.0002) subscales of the AD-ACL. An examination of the b weights in the final equation shows that none of the variables significant at the point of entry remained so.

Insert Table 2 about here

Fitness-Activity Group

Group differences emerged in the Energy (R^2=.044, F(4,91)=4.54, p<.04) and Tension (R^2=.050, F(4,91)=6.09, p<.05) subscales of the AD-ACL. However, the b weight in the final equation did not remain significant.

Subject Dummy Variables

Anywhere from 9.4% to 57.4% of the variance was explained by residual between subject variability accounted for by the 23 (N - 1) dummy coded vectors. This result indicates that individual differences play a significant role in the experience of mood.

State Meta-Mood Variables

Above and beyond all the variability explained by subject and fitness manipulations, SMMS subscales entered as a block accounted for significant amounts of variability in the FS (R^2=.161, F(28,67)=7.21, p<.00001), NA (R^2=.172, F(28,67) 14.90, p<.00001), Energy (R^2=.068, F(28,67)=2.54, p<.04), and Tension (R^2 .095, F(28,67) 3.46, p<.008). Specifically, for the FS scale, the higher the acceptance score, the higher the FS score (b=.802, p<.004). For NA, the more the subjects reported that their mood was under control, the lower the score for NA (b=-.403, p<.0001). A similar pattern was observed for Tension in that the higher the score for control, the lower the perceived levels of tension. No b weights remained significant in the final equation for the energy subscale.

Pre-Test Mood Scores

Although many precautions were taken in choosing subjects in terms of fitness and activity levels as well as keeping them blind to the hypotheses and purposes of the experiment, some anticipatory effects may have been present. In order to control for these effects, the pre-test mood scores were entered at this point of the regression equation. All pre-test scores were significant for all seven mood subscales [2].

Experimental Condition

Condition effects were found for FS (R^2=.015, F(30,65)=4.72, p<.03) and Tiredness (R^2 022, F(30,65)=4.59, p<.04). The b weights did not remain significant in the final equation.

Time of Measurement

For time, R^2 change was significant for FS (R^2=.032, F(31,64)=11.80, p<.001), Calmness (R^2 .022, F(31,64)=4.60, p<.04) and Tension (R^2=.038, F(31,64)=12.60, p<.0007). Only the b weight for Calmness (b=.51, p<.02) remained significant indicating that the subjects felt calmer at the post-exercise measure than at the pre-exercise measure.

Condition by Time Interaction

An examination of significant interactions paints a more complete picture of exercise-related mood changes. The condition by time interaction was significant at the point of entry for the FS (R^2 .018, F(32,63)=7.19, p<.009), PA (R^2=.044, F(32,63)=16.18, p<.0002),

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[2]We chose not to interpret either the amounts of variance explained or the b weights because we recognize that there may be a confound in these values. The confound relates to the prediction of post-test scores by pre-test scores. However, we felt this was an important step in the hierarchical regression in order to remove the effects of any pre-test differences in post-test scores.

Energy (R^2=.026, F(32,63)=7.79, p<.007), Calmness (R^2=.035, F(32,63) 8.16, p<.006), and Tiredness (R^2=.034, F(32,63)=8.08, p<.006). The b weight for the FS stayed significant (b=6.280, p<.035). An illustration (See Figure 1) of the predicted curve of the interaction effect indicates that the observed FS in the exercise condition does not occur in the same fashion as in the control condition. Specifically, the graph shows that FS is relatively stable in the control condition, but increases sharply in the exercise condition. For the Calmness subscale (b=-4.402, p<.05), the illustration depicts a slight increase for the attention-control conditions but a sharp decrease in the exercise condition.

Insert Figure 1 here

Condition by Group, Group by Time, Group by Condition by Time Interactions

None of these interaction effects were significant.

State Meta-Mood Variables by Condition by Time Interaction

In order to test for a moderating role of state meta-mood and trait meta-mood variables in exercise-induced mood changes, a series of three-way interaction terms involving pre- to post-treatment changes, experimental conditions and meta-mood variables were constructed and entered into the equation. The state meta-mood by time interaction was significant for FS (R^2=.033, F(40,55)=3.05, p<.02). Unfortunately, none of the b weights were significant in the final equation, indicating that state meta-mood variables do not play a moderating role in exercise-induced mood changes.

Trait Meta-Mood Variables by Condition by Time Interaction

The trait meta-mood variable interaction terms were the last block of predictors entered into the equation. For the Energy subscale, the interaction was significant at the point of entry (R^2=.036, $F(43,52)=4.74$, $p<.005$). An examination of the final b weights indicated significant effects for Attention X Condition X Time interaction ($b=1.050$, $p<.0006$) and the Repair X Condition X Time interaction ($b=.935$, $p<.02$). This variable is a *trait* and, as such, is a between-subjects variable.

Figure 2 illustrates the predicted regression lines for each of the experimental conditions and measurement times. For the attention subscale, results indicate that individuals who pay attention to their mood have greater perceived energy in the post-exercise condition than in the pre-exercise and either of the control times. Conversely, those individuals who do not pay much attention to their moods perceive that they have less energy in the post-exercise condition than at any other time. A similar pattern emerges for the Maintenance/Repair subscale. Individuals who have an ability to regulate their mood perceive more energy post exercise than pre exercise, pre control or post control. However, individuals who do not report having the ability to regulate mood perceive energy as greater in the control or pre-exercise conditions.

Insert Figure 2 here

Discussion

The purpose of this research was to examine the role of meta-mood cognitions and

abilities in moderating the effects of acute exercise on mood. Some evidence was found to support the idea that selected trait meta-mood variables moderate exercise-related changes in energy. Specifically, individuals who pay attention to their moods and who attempt to regulate them experience more feelings of energy post exercise than pre exercise, pre control, or post control.

Furthermore, support was found for the idea that selected meta-mood variables are related to mood. That is, the SMMS subscales explained between 2.3 and 17.1% of the overall variance. The significant variances were for FS, NA, Energy and Tension subscales. Specifically, the more the subject was accepting of the mood, the higher the subject rated the mood as favorable. For control, the more the subjects wanted to control their mood, the higher the NA they were experiencing. In addition, a similar pattern was observed for the Tension subscale.

While encouraging, these findings are in no way parsimonious. A greater consistency in portions of variance explained across criterion variables coupled with a greater number of significant moderator variables would have provided stronger evidence of the moderating role of meta-mood variables in relation to mood and in regulating exercise-enhanced mood.

Before the moderating role was established, however, I examined some other hypotheses in greater detail. It was hypothesized that the mood patterns reported would follow those reported in the literature (i.e. subjects would experience an increase in favorable moods following the exercise bout). Specifically, FS, PA (PANAS), Calmness (AD-ACL), and Energy (AD-ACL) would increase following exercise and NA (PANAS), Tiredness (AD-ACL), and Tension (AD-ACL) would decrease following the exercise bout. However,

analyses showed that not all the results are in line with these hypotheses. At post exercise, most subjects did not seem to differ greatly in mood from the mood recorded during the attention-control condition, even though they indicated feeling better on the FS and feeling less calm on the AD-ACL. The results are complicated by the fact that pre-exercise levels were different across experimental and control manipulations despite efforts to induce a neutral mood prior to any treatment. Differences in pre-exercise moods across conditions is not a new phenomenon in the literature. However, in future studies, researchers would do well to increase sample sizes and invest more time in creating equivalent moods prior to exercise involvement. Similarly, the absence of differences between conditions at post test could be related to insensitive measurement instruments or floor effects on certain dependent measures (e.g. tension and tiredness). The availability of new instruments such as the Exercise-induced Feeling Inventory (EFI, Gauvin & Rejeski, 1993) and Subject Exercise Experience Scale (SEES, McAuley & Courneya, 1994) should alleviate the latter problem while the examination of different populations could shed light on the former issue.

Regarding residual between subject-variability, the regression equation paints a similar picture for each of the criterion variables. In all cases, subject variability explains a great deal of the overall variance (between 9.4% and 57.4%). This is not surprising, as similar results have been found when measuring mood at various points of the day (e.g. Marco & Suls, 1993). However, the fact that such a large portion of the variance still remains unaccounted for suggests that the search for other moderating variables as well as individual difference variables should be pursued.

Overall, the major conclusion that can be drawn from this study is that neither the

fitness level of the individuals nor the exercise bout has a great impact on mood. Rather it is the subjects' meta-mood cognitions that seem to be most strongly related to mood. The presence of the trait meta-mood subscales as moderating variables is encouraging considering the fact that an additional 3.6% of the variance was explained when 83.2% had already been accounted for in the Energy subscale of the AD-ACL. These data call for further replication and extension. Future research should examine the nature of the MMC and MMA, describing their content as well as their impact on the exercise experience. This could be achieved through qualitative analyses. Moreover, greater differences in exercise intensities should be employed since experimental differences were not overwhelming. That is, 70% of maximum heart-rate reserve may not have elicited the acute mood changes desired. Subjects should perhaps be further screened to reveal exercise history beyond the previous four months to ensure that sedentary subjects were not previously exercisers. Finally, there is a need for more refined research instruments aimed at investigating subtle changes in mood and meta-mood.

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Table 1.

Summary Statistics of manipulation checks (means and sd).

Effect Mean(sd)	Fit-Active	Unfit-Inactive	All
Age	23.42(4.40)	21.42(1.98)	22.42(3.49)
Weight,kg	59.70(10.77)	67.55(18.53)	63.63(15.35)
Max VO2	47.70(5.61)	32.40(6.02)	40.05(9.67)*
EBQ	5.75(0.45)	2.92(1.68)	4.33(1.88)*
HR,rest	63.50(11.92)	79.08(8.98)	71.29(13.04)*
HR, Exercise	150.08(5.35)	156.92(2.91)	153.50(5.47)*
RPE	14.25(1.96)	15.42(2.31)	14.83(2.18)*

* $p < .01$

Table 2

Results of hierarchical regression analysis (separate analysis for each of the mood scales)

Step/source Cum % (delta %) b weight	FS	PANAS PA	PANAS NA
Trait Meta-Mood Variables	**.260(.260)****	**.135(.135)****	**.338(.338)****
Repair	770	-.185	136
Clarity	.195	- 239	- 056
Attention	-.366	- 069	051
Fitness-Activity Group	**.263(.003)**	**.152(.018)**	**.355(.017)**
High vs Low	- 705	.365	006
Subject Dummy Variables	**.541(.278)****	**.686(.533)****	**.674(.318)****
State Meta-Mood Variables	**.701(.161)****	**.709(.023)**	**.845(.172)****
Typicality	279	-.035	005
Acceptance	.802**	- 096	- 091
Change/Stability	- 159	.029	065
Clarity	- 111	414	- 064
Control	-.150	-.180	- 403***
Pre-Test Mood Scores	**.778(.079)****	**.784(.075)****	**.899(.054)****
Pre-test mood score	448***	.566***	399***
Experimental Condition	**.794(.015)***	**.784(.0005)**	**.902(.003)**
High vs control	- 037	- 342*	- 029
Time of Measurement	**.826(.032)****	**.785(.001)**	**.907(.005)**
Post vs Pre	- 019	- 450**	- 036
Condition by Time	**.844(.018)****	**.829(.044)****	**.908(.0005)**
C X T	6.28*	.599	150
Condition by Group	**.847(.003)**	**.831(.002)**	**.908(.0005)**
C X G	516	242	- 035

Group by Time	**.848(.001)**	**.834(.003)**	**.908(.00009)**
G X T	.325	.290	- 007
Condition by Group by Time	**.849(.002)**	**.838(.004)**	**.908(.00008)**
C X G X T	-.155	-.300	- 009
State Meta-Mood Cond. by Time	**.882(.033)***	**.862(.025)**	**.920(.012)**
Change/Stability X C X T	- 014	- 452*	-.011
Clarity X C X T	- 220	-.434*	-.151
Typicality X C X T	-.559	.129	120
Acceptance X C X T	.143	-.021	073
Control X C X T	-.600	182	163
Trait Meta-Mood by Time	**.884(.002)**	**.867(.005)**	**.925(.005)**
Attention X C X T	.094	.239	- 093
Clarity X C X T	- 194	.221	.100
Repair X C X T	- 245	094	- 267
Constant	-3 23	2.42	2 314**
N of concatenated responses	96	96	96

* p< 05
** p< 01
*** p< 001

Table 2 (continued)

Results of hierarchical regression analysis (separate analysis for each of the mood scales).

Step/source Cum % (delta %) b weight	AD-ACL Energy	AD-ACL Calmness	AD-ACL Tiredness	AD-ACL Tension
Trait Meta-Mood Variables	**.081(.081)***	**.013(.013)**	**.041(.041)**	**.196(.196)*****
Repair	- 758	- 392	328	- 013
Clarity	068	460	- 166	089
Attention	- 294	-.236	.002	075
Fitness-Activity Group	**.125(.044)***	**.016(.002)**	**.051(.010)**	**.246(.050)***
High vs Low	390	051	-.041	- 128
Subject Dummy Variables	**.574(.449)*****	**.537(.522)*****	**.444(.393)*****	**.538(.292)****
State Meta-Mood Variables	**.642(.068)***	**.563(.026)**	**.520(.077)**	**.633(.095)****
Typicality	.034	071	.016	- 060
Acceptance	- 114	132	170	- 046
Change/Stability	- 113	055	107	016
Clarity	.212	-.427*	- 057	130
Control	- 113	197	- 241	- 354*
Pre-Test Mood Scores	**.753(.112)*****	**.670(.107)*****	**.669(.148)*****	**.770(.137)*****
Pre-test mood score	.655***	596***	604***	650***
Experimental Condition	**.759(.006)**	**.675(.004)**	**.691(.022)***	**.770(.0001)**
High vs control	-.263	305	017	- 064
Time of Measurement	**.764(.005)**	**.697(.022)***	**.702(.011)**	**.807(.038)*****
Post vs Pre	388*	.513*	.287	- 152
Condition by Time	**.790(.026)****	**.731(.035)****	**.736(.034)****	**.812(.005)**
C X T	-1 859	-4 402*	-1 657	1 463
Condition by Group	**.790(.0009)**	**.732(.0002)**	**.738(.002)**	**.818(.006)**
C X G	281	- 244	001	020

Group by Time	**.792(.002)**	**.733(.001)**	**.739(.0006)**	**.820(.002)**
G X T	.041	-.047	.225	-.243
Cond. by Group by Time	**.799(.006)**	**.737(.004)**	**.739(.0003)**	**.823(.002)**
C X G X T	- 273	- 036	-.566	410
State Meta-Mood by Time	**.832(.034)**	**.778(.041)**	**.772(.033)**	**.832(.009)**
Change/Stab X C X T	-.714**	.452	.640*	-.169
Clarity X C X T	.015	386	.116	.031
Typicality X C X T	-.421	.689*	.454	-.194
Acceptance X C X T	.342	-.162	-.071	-.188
Control X C X T	-.237	-.727	- 244	.343
Trait Meta-Mood by Time	**.868(.036)****	**.800(.022)**	**.780(.008)**	**.838(.006)**
Attention X C X T	1.050***	- 055	-.246	- 211
Clarity X C X T	-.196	051	4~7	-.217
Repair X C X T	935*	.726	- 470	- 023
Constant	4.287*	1.328	.516	1.265
N of concatenated responses	96	96	96	96

* p< 05
** p< 01
*** p<.001

Figure 1: Condition by Time interactions for the Feeling Scale and the Calmness subscales of the AD-ACL.

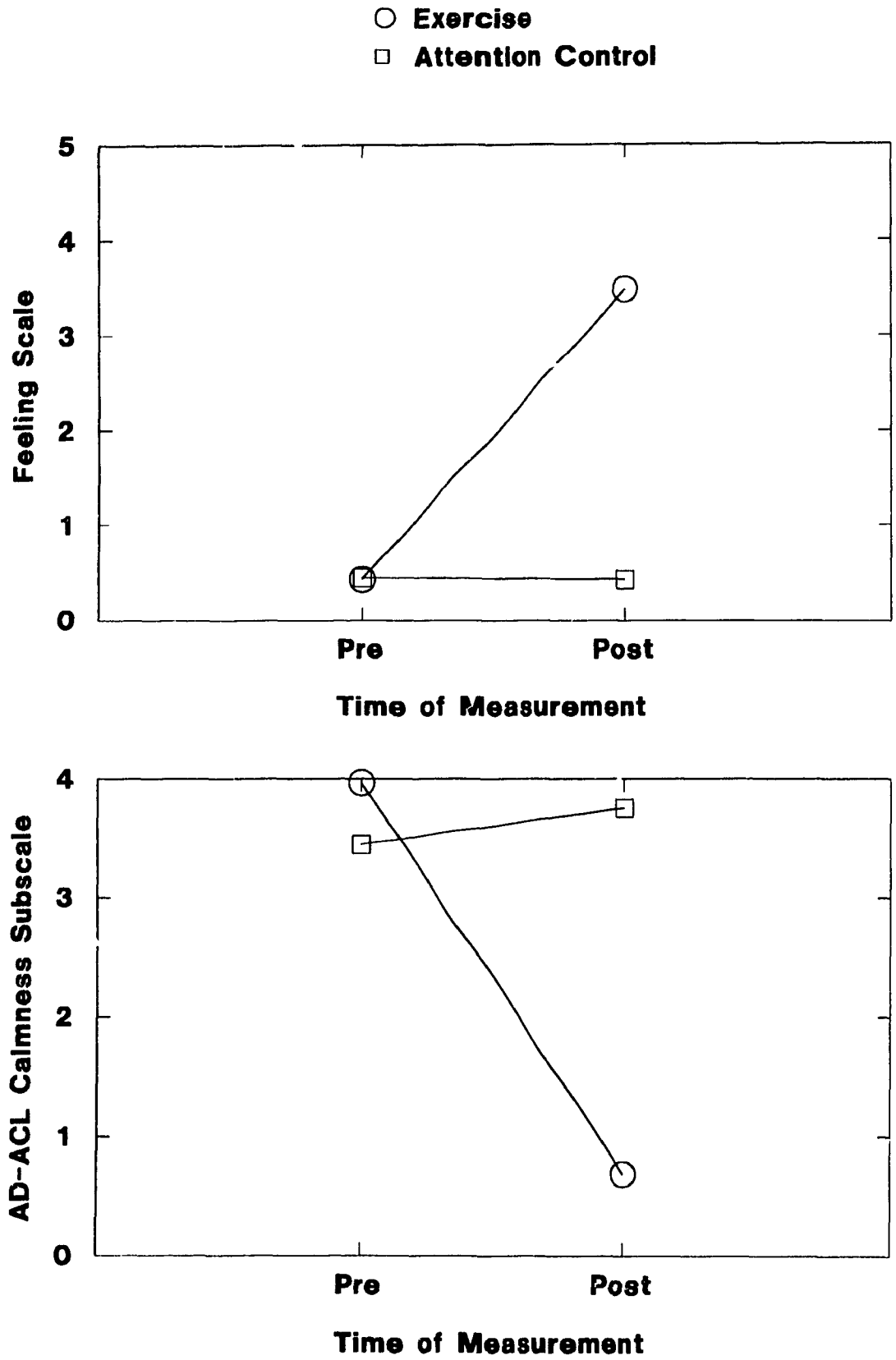
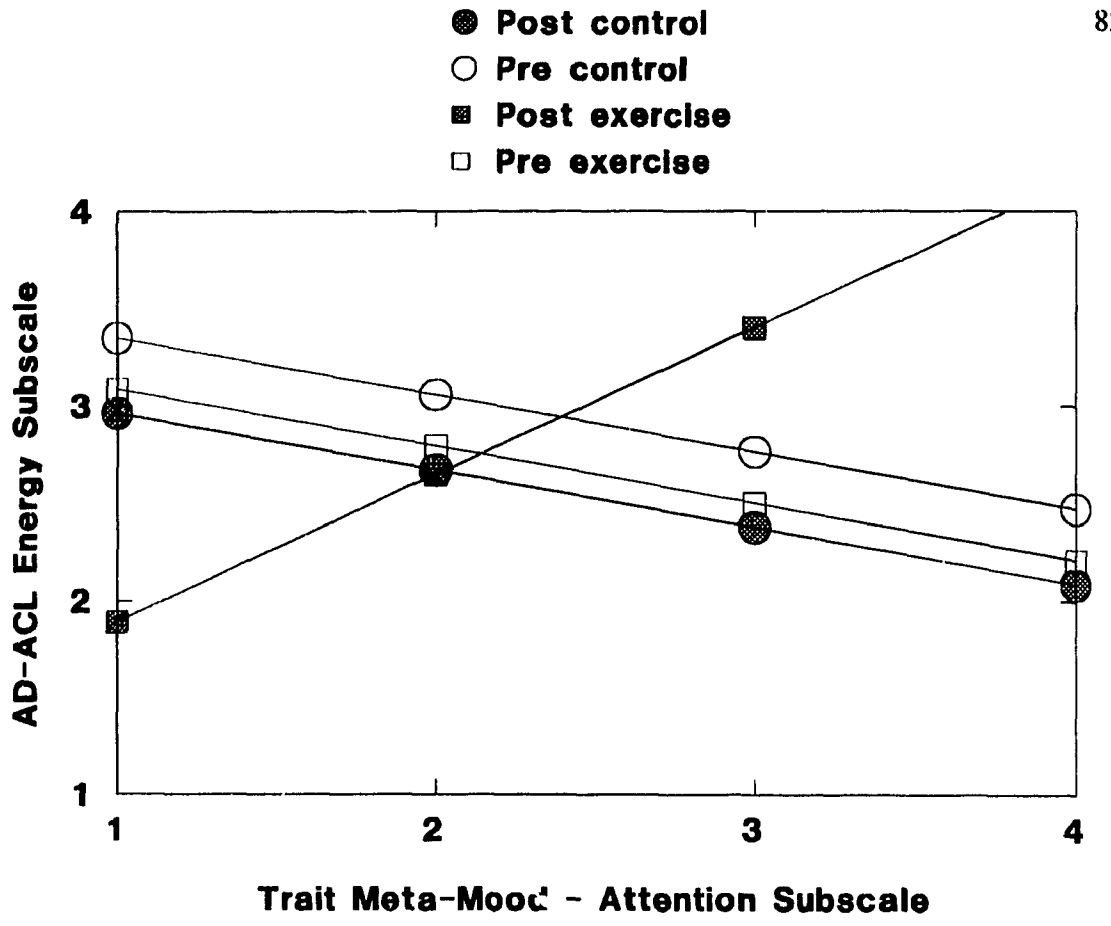
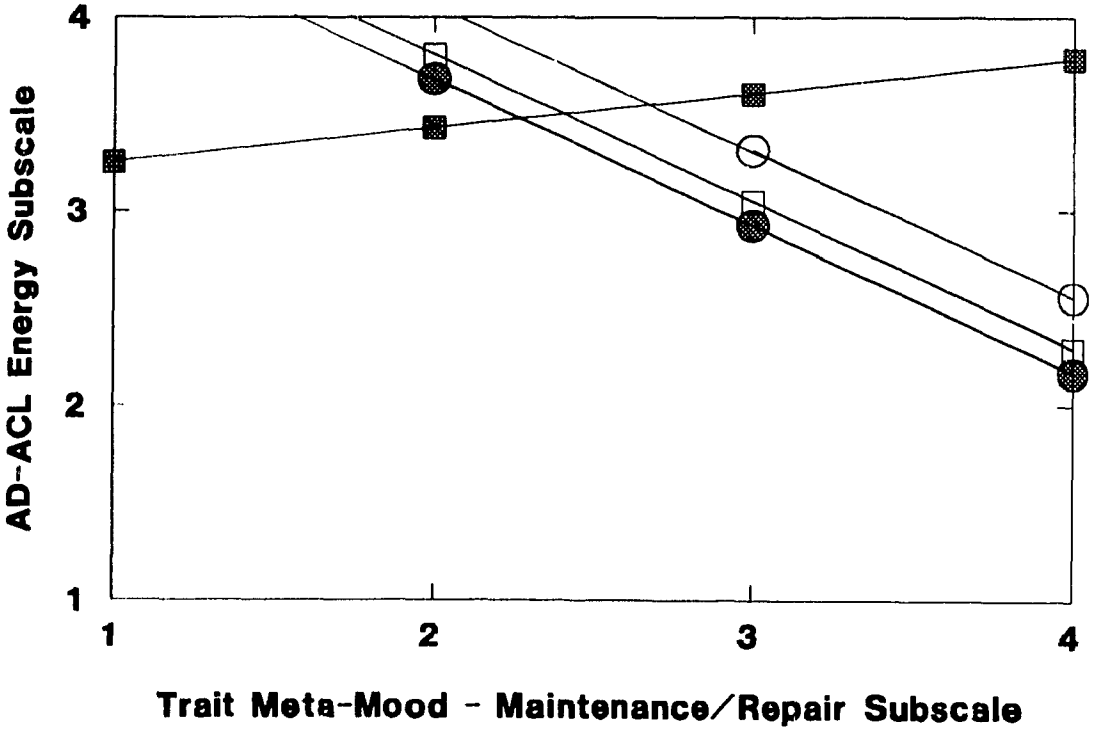

Exercise
Attention Control
Feeling Scale
5
4
3
2
1
0
Pre
Post
Time of Measurement
AD-ACL Calmness Subscale
4
3
2
1
0
Pre
Post
Time of Measurement

Figure 2: Predicted lines of the TMMS moderator variables on the Energy subscale of the AD-ACL.


Post control
Pre control
Post exercise
Pre exercise
AD-ACL Energy Subscale
4
3
2
1
1
2
3
4
Trait Meta-Mood - Attention Subscale


AD-ACL Energy Subscale
4
3
2
1
1
2
3
4
Trait Meta-Mood - Maintenance/Repair Subscale

Exploring the Moderating Effects of Level of Thinking on Mood Changes Associated with Acute Exercise in Female Runners

Abstract

The purpose of this study was to examine the role of thoughts and level of thinking during running in moderating the effects of exercise-induced mood. Eleven (11) habitual runners were recruited to participate in two running sessions. Session 1 served as a free-exercise control session where the subjects ran at their own preferred pace. Session 2 required the subjects to run at 70% of their maximum heart-rate reserve. Sessions were counterbalanced. Mood was measured through the Exercise-Induced Feeling Inventory (EFI, Gauvin & Rejeski, 1993) and the Feeling Scale (FS, 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 subjects to talk into a hand-held tape recorder for five minutes. 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. Subjects ran for a total of 40 minutes. Thoughts recorded while the subjects ran were coded into different categories according to their content. Results indicated that the content of thoughts, specifically, *inner thoughts and feelings*, *body monitoring*, and *problem solving* are 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. Conversely, *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, higher levels of FS, positive engagement and tranquility were found post exercise than pre exercise. Future directions are discussed.

Exploring the Moderating Effects of Level of Thinking on Mood Changes Associated with Acute Exercise in Female Runners

Researchers investigating the psychological effects of exercise on well-being are exploring mood benefits associated with participation in acute exercise (Petruzzello, Landers, Hatfield, Kubitz & Salazar, 1991; North, McCullagh & Tran, 1990). Past research typically required subjects to cycle or run at a given intensity and to complete a standard battery of mood questionnaires. This methodology, although adequate for ascertaining the existence of exercise-induced mood changes, does not shed light on the presence of moderator variables. The identification of moderator variables is one viable strategy towards developing an understanding of the phenomenon of exercise-induced mood changes (Baron & Kenny, 1986).

One variable that may play a role in regulating feeling states is the degree of self-reflectiveness of thoughts or level of thinking (Pennebaker, 1989) which occurs during acute bouts of exercise through the application of the *Stream-of-Consciousness* methodology (James, 1890). The purpose of this study was to investigate the potential moderating role that level of thinking during exercise may have on feeling states. Although the study of thoughts during exercise is not novel, the use of alternative concepts and methodologies may complement the existing literature (c.f. Gauvin & Brawley, 1993).

Thoughts During Exercise: Extant Literature

Morgan and Pollack (1977) pioneered the study of thoughts during exercise by interviewing elite marathon runners to determine if differences in thinking between elite and non-elite runners could be distinguished. The results indicated that non-elite runners tended

to dissociate, that is, think of something else 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. Association is defined as thinking of physiological processes occurring during running (e.g. muscle cramps, heart rate, and respiration rate) The elite runners used association to monitor their bodies and judge the amounts of energy reserve during a race. They dissociated when faced with a difficult portion of the course (Morgan, 1978) Because only the relationship between thoughts and performance was examined, limitations to this research prevent us from drawing out any evidence of the relationship of content of thought and feeling states.

Other researchers (Johnson & Seigal, 1992; Pennebaker & Lightner, 1980) have found that associative or dissociative thinking has an impact on perceived exertion and fatigue. Subjects asked to associate by thinking of physiological processes or by listening to their own amplified breathing while exercising reported that they exerted themselves much more or reported higher levels of fatigue than subjects asked to dissociate by talking with the researchers, listening to street noises, or counting cars. These studies, although methodologically superior to Morgan and Pollack (1977) in that control groups were used, do not examine the impact of thoughts on mood which is the general goal of this research.

Schomer (1986) also attempted to investigate the characteristics of thinking in marathon and novice runners. Stemming from Morgan and Pollack's (1977) work on dissociative and associative strategies, Schomer strived to develop a mental training strategy to teach to the novice runners. The subjects in this study were required to talk continuously into a tape recorder while running. The tapes were then transcribed to text to facilitate

analysis. It should be noted that neither mood, nor perception of physical sensations questionnaires were administered nor were any heart-rate data recorded. The text was then coded into the following categories. *Feelings and affect, body monitoring; command and instruction, pace monitoring, environmental feedback; reflective activity thoughts; personal problem solving; work, career and management*; and *course information*. Schomer (1986) found a positive relationship between associative mental strategies and perceived effort (i.e. the more associative the mental strategy, the more perceived effort the subjects felt). Unfortunately, Schomer's (1986) study seems to have been content-based, and not conceptually based and therefore has limitations. In addition, since no physiological indicators of exercise intensity were reported, conclusions drawn are tenuous at best.

The only researchers specifically examining thoughts during running and their effects on mood were Goode and Roth (1993). They developed a questionnaire, the Thoughts During Running questionnaire (TDR), through the use of interview data. Although this instrument is the first to quantify cognitions during exercise, the authors propose that a larger factor structure would encompass thoughts which may occur, but are not included in the scale (Goode & Roth, 1993). However, using exploratory factor analysis, a five-factor structure yielded a pool of 32 items. The resulting questionnaire was administered to 533 university students who reported walking or running for exercise. A factor analysis yielded a five-factor structure, revealing that thoughts during running could be grouped into five categories, namely *associative, external surroundings, interpersonal relationships, daily events*, and *spiritual reflection*. A sample item of each of the factors includes, 'how my body feels' for *associative*, 'nature' for *external surroundings*, 'my girlfriend or boyfriend' for *interpersonal*

relationships, 'financial matters' for *daily events*, and 'religious thoughts' for *spiritual reflection*. It should be noted that one factor has remained 'associative', but the four others are 'dissociative'.

In a follow-up to scale development, the Profile of Mood States (POMS, McNair, 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 correlation results indicated that decreases in tension were associated with thinking about *interpersonal relationships*, and increases in vigor with thinking about *external surroundings, interpersonal relationships*, and *daily events*. Increases in fatigue were related to *associative* thinking, but decreases in fatigue were reported for *interpersonal relationships* and *daily events*. While these results are interesting, they are nonetheless limiting because measures were taken post exercise and retrospective data may not be as reliable as obtaining moment-by-moment data during the activity.

In order to overcome some of the limitations of the previous research and to identify moderator variables, I studied the relationship between mood, meta-mood and exercise. Meta-mood refers to the thoughts people entertain about mood (Mayer & Gaschke, 1988, Mayer, Salovey, Gomberg-Kaufman & Blainey, 1991). Twenty-four (24) active and inactive female subjects participated in exercise and control conditions and completed mood questionnaires prior to and following 30 minutes of exercise at 70% of their respective heart-rate reserves. Subjects also reported ongoing thoughts about mood during the exercise and control conditions and completed questionnaires designed to assess mood monitoring and mood regulating abilities. Results of this study indicated that mood changes occurring at

differe 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 pay more attention to their moods have greater perceived energy post exercise than they do pre exercise Similarly, individuals who have an ability to regulate their mood also perceive higher levels of energy in the post-exercise measures than in the pre-exercise measures No moderating role was observed for ongoing thoughts about mood

The results of the study described above do not support the existence of a moderating role of selected thoughts on exercise-induced mood. However, it may be that the meta-mood scales used did not properly assess what the thoughts were and how the subjects were processing these thoughts. In addition, perhaps transient thoughts moderate exercise-induced moods, but the approaches used in previous work have not allowed us to address this issue.

Alternative Research Strategies: Levels of Thinking

The research conducted by Pennebaker and his colleagues (Pennebaker, Czajka, Cropanzano, & Richards, 1990) offers an alternative methodology to explore not only what individuals may be thinking, but how they are processing these thoughts. Specifically, Pennebaker proposes that thinking and thoughts fall along a continuum of self-awareness and introspection High-level thinking is defined as having thoughts which are highly self-reflective and "demonstrate an awareness of emotion" (Pennebaker et al., 1990, p. 743). Low level thinking is mundane and void of any self-awareness. In order to investigate "the content and structure of thought", Pennebaker (1990, p. 745) used a *Stream-of-Consciousness* technique first developed by James (1890). By asking subjects to write down everything that

passed through their mind, James observed that the way in which they thought changed according to their emotional and physical states (Pennebaker, 1989). Pennebaker attempted to establish the reliability and validity of this technique in conjunction with physical symptoms and psychological states questionnaires. Results of this study demonstrated that level of thinking was stable over time and method of data collection, indicating that talking or writing was of little consequence to the information being presented. Other results indicated that the higher the level of thinking, the more self-references were included in the text.

Results of the meta-mood study described earlier indicated that individuals who were attentive to their moods and had the ability to regulate mood attained more favorable exercise-induced mood. Through having established the moderating role of meta-mood abilities, it would appear that focusing on thoughts and feelings is a pre-requisite for accruing exercise-induced mood benefits. Following Pennebaker's (1989) definition, higher levels of thinking require self-reflectiveness and introspection. Therefore, it is viable to examine level of thinking as an alternative means of investigating the processes which individuals use in gauging mood changes.

Studying meta-mood cognitions specifically examines what people are thinking about their moods. Using Pennebaker's level of thinking technique, other kinds of information can be gathered. This method can help researchers decipher not only *what* people are thinking about, but more interestingly, *how* people are processing this information.

The Present Study

The purpose of this investigation was to examine the role of level of thinking in moderating the effects of acute exercise in female runners. Female subjects were chosen to

participate in this research in order to preserve same-sex experimenter (Rosenthal & Rosnow, 1984). Additionally, it has been reported that women are more sensitive to changes in positive and negative emotions (Larsen & Deiner, 1987).

For this research, female habitual runners were recruited to participate in two exercise sessions: one at 70% of their heart-rate reserve and the other, at a pace of their choice (free-exercise control)[1]. Mood responses were taken pre and post exercise while the *stream of consciousness* was administered twice during the exercise bout. Data were analyzed through a hierarchical repeated-measures regression analysis (Pedhazur, 1982).

Methodology

Subjects

Eleven (11) physically fit female runners were recruited from local running and fitness clubs and a large university. Demographic information for these runners is presented in Table 1. The runners were classified as habitual because they ran an average of 40 km per week at a frequency of four or five times per week. They were invited to participate in each of two sessions of this study.

Insert Table 1 Here

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[1]A third manipulation was also conducted where the subjects ran for 20 minutes at 40% and 20 minutes at 70% of their heart-rate reserve. This condition was dropped from the analysis because it was felt that it would create additional variability, which would be statistically unwise due to the small number of subjects.

Measurement Instruments

Mood questionnaires. Two mood questionnaires were administered to the subjects: the Feeling Scale (FS, Hardy & Rejeski, 1989) and the Exercise-Induced Feeling Inventory (EFI, Gauvin & Rejeski, 1993). The FS is a one-item questionnaire that requires the subject to indicate how good or bad their feeling state is at the present moment. The subject selects a number on a scale from -5 to +5 with verbal anchors at the odd integers. Although the FS has not been tested for reliability, the concurrent validity with the Rate of Perceived Exertion Scale (RPE, Borg & Noble, 1974) is high ($r = .56$, $p < .00001$).

The EFI (Gauvin & Rejeski, 1993) consists of 12 adjectives for which the subjects must rate on a five-point scale how they feel at the moment. The five choices available are 'do not feel', 'feel slightly', 'feel moderately', 'feel strongly', and 'feel very strongly'. The 12 adjectives are representative of four factors including *positive engagement*, *revitalization*, *tranquility*, and *physical exhaustion*. Examples of the items included in each subscale are 'enthusiastic' for *positive engagement*, 'refreshed' for *revitalization*, 'calm' for *tranquility*, and 'fatigued' for *physical exhaustion*. Internal consistencies were .87 for *revitalization*, .91 for *physical exhaustion*, .82 for *tranquility*, 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) were collected during the exercise. This measure of how hard a person thinks they are working has a test-retest reliability of .80 and correlates with measures of heart rate ($r = .56$ to $.68$). For example, a score of 11 would indicate that the subject is running at a fairly light workload and would correspond to a heart

rate of 110 beats per minute. A score of 17 would indicate a very hard workload and would subsequently correspond to a heart rate of 170 beats per minute.

Qualitative measures. A *stream-of-consciousness* technique as described earlier was used for the purpose of recording thoughts during running. This technique requires the subject to talk into a hand-held tape recorder. The subject must verbalize everything and anything that passes through their mind (Pennebaker, 1989).

Procedure

Subjects were met at their indoor exercise site and fitted with a heart-rate monitor (Sport Tester Polar Electro model PE 3000). The runners were asked to answer the Feeling Scale (FS, Hardy & Rejeski, 1989) and the Exercise-Induced Feeling Inventory (EFI, Gauvin & Rejeski, 1994) prior to the run. The exercise intensities of the two counterbalanced sessions were 70% of heart-rate reserve for one and free exercise control for the other. Fifteen minutes into the run, the subjects were given a tape recorder and asked to continue running while talking about anything that was on their mind. After talking for five minutes, the subject stopped running, filled out the Rate of Perceived Exertion Scale (RPE, Borg, 1974), then resumed running at the pace they were previously running. Thirty-five minutes following the start of the run, subjects were again asked to talk into the tape recorder. Five minutes later, they were asked to stop running and fill out the RPE. At this point, the subjects were instructed to do their cool down. When their heart rate returned to within 10 beats of their resting heart rate (approximately 30 minutes later), post-mood measures were taken. [2]

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[2]Pre- and post-*stream-of-consciousness* data was also collected but is beyond the scope of this particular paper. See Appendix B for summary of procedures.

Data Reduction and Coding

The data collected on the tape recorders was analyzed by breaking down the information into thoughts. A 'thought' ended when the subject matter changed. Each 'thought' become a unit of analysis and these units were coded into different categories according to their content. The categories were established through an aggregate of the categories used by Pennebaker et al. (1990), Schomer (1986), and Goode and Roth (1993)

As elaborated earlier, the research questions posed in this study differ enough to warrant a new set of categories based on the work done by previous researchers. Since the present study investigated what and how people think, many of the categories were collapsed into broader classification units. Goode and Roth's (1993) five categories were kept intact since they were comparable to those of Schomer (1986) and Pennebaker et al. (1990). For example, Schomer's (1986) definition of *pace monitoring* includes *environmental feedback* which is essentially the same as *external surroundings*. In addition, Schomer (1986) grouped thoughts about work, career, and household chores under the same category. Using Goode and Roth's (1993) coding scheme, the nature of thoughts is more precisely encoded because although household chores are most probably coded under *daily event*, work can be under *daily event* or *problem solving*.

The *people* category was an aggregate of siblings, parents, children, friends, clubmates, etc. These categories were all collapsed into one under the heading *interpersonal relationships*. This latter category captures the essence of the relationship between the narrator and the person they are speaking about more than merely the legal relationship. *Body monitoring* was retained from Schomer's categories because it is subtly different from

association in that association to exercise encompasses much more than the observation of physiological sensations. *Thoughts and feelings* was also retained from Schomer (1986) because Goode and Roth (1993) did not include any category containing thoughts the subjects may have been entertaining about their feelings and thoughts about what they were thinking. *Idle conversation and chatter* was eliminated because subjects were instructed not to talk to anyone during the run. The *level of thinking* category was retained from Pennebaker et al. (1990). Finally, *valence* was added as a category because we felt that overall positiveness or negativeness may influence level of thinking and feeling state. Table 2 presents examples of statements which belong to each category.

Thus, the final scheme included *valence, people, associative, thoughts and feelings, daily events, interpersonal relationships, external surroundings, body monitoring, problem solving,* and *spiritual reflection*. Each of the categories, from *people* through to *spiritual reflection*, had a '0' ascribed if the thought did not fit into this category and a '1' if it did. In coding for valence, the choices were '-1' for negative, '0' for neutral, and '+1' for positive tone. Finally, each thought was coded for level of thinking on a continuum of 1 to 5.

Two raters coded each thought separately. Intercoder reliability was established separately for each category by subtracting the number of thoughts that the coders did not agree upon from the number of total thoughts and dividing by the number of total thoughts. A Cohen's Kappa was not calculated since the categories were not mutually exclusive. The reliabilities range from 86% for *thoughts and feelings* to 100% for *spiritual reflection*. *Level of thinking*, being a continuous variable and thus more difficult to code, was initially established at 76% but increased to 86% during a second coding. All items that were in non-

agreement were discussed until a consensus was reached.

Insert Table 2 Here

Preliminary Analyses: Thoughts During Running

The purpose of the preliminary analyses was to examine if the content of thoughts had an impact on the level of thinking. Frequency counts of the number of thoughts that fit into each of the categories were taken. A t-test was conducted on each of the categories to see if the number of references to each category differed. In order to examine if the content of thoughts was related to level of thinking, a hierarchical regression for repeated measures (Pedhazur, 1982; Michela, 1990) was conducted by using each of the different categories as predictor variables and *level of thinking* as a criterion variable. The predictor variables were entered in the following manner: Between-subject variables were entered in the equation first as a series of dummy coded variables to remove any residuals; the second step entered in the regression equation was the condition dummy code, in order to compare the 70% exercise and the free-exercise control conditions. Within-subject effects were removed in the next steps. Time dummy-coded variables were entered at the third step. This dummy-code vector was created to differentiate between pre and post exercise. The interaction term of condition by time was entered at the fourth step. The fifth step was comprised of entering the valence variables. The categories of thought were entered as a block at the final step. The final regression model was as follows:

$$Y = b_0 + [b_1S1 + \ldots + b_{10}S10] + b_{11}\text{Condition} + b_{12}\text{Time} + b_{13}C^*T + b_{14}\text{Valence} + [b_{15}\text{People}$$

+ b_{16}Problem Solving + b_{17}Body Monitoring + b_{18}Thoughts & Feelings + b_{19}Association + b_{20}External Surroundings + b_{21}Interpersonal Relationships + b_{22}Daily Events + b_{23}Spirtual Reflection]

Main Analysis: Thoughts During Running, Levels of Thinking and Mood

The purpose of this analysis was to examine if the way people are processing information is related to their feeling states. Frequency counts of the number of thoughts that fit into each of the categories were taken. Since all subjects did not have the same number of thoughts, percentages were calculated

Two hierarchical regressions for repeated measures (Pedhazur, 1982; Michela, 1990) were conducted by first using each of the different categories as predictor variables and feeling states as criterion variables and second, *level of thinking* as a predictor variable and feeling states as criterion variables The predicting variables were entered in the following manner: Between-subject variables were entered in the equation first as a series of dummy-coded variables in order to remove any residuals. Within subject effects were removed with the next steps. The second step was entering the pre-test mood scores to remove differences which may have occurred at the pre-test from the time effects. The third step consisted of entering a condition dummy code to compare between the 70% exercise and the free-exercise control conditions. Time dummy-coded variables were entered at the fourth step. This dummy-code vector was created to differentiate between pre and post exercise. The interaction term of condition by time was entered at the fifth step. The sixth step consisted of entering the valence variables The differing categories were entered as a block at the seventh step. In the last step, the final block of variables, category by time interactions, was

entered into the equation to test for moderator effects. The final regression model was as follows:

$Y = b_0 + [b_1S1 + ... + b_{10}S10] + b_{11}$Pre-test mood scores $+ b_{12}$Condition $+ b_{13}$Time $b_{14}C^*T + b_{15}$Valence $+ [b_{16}$People $+ b_{17}$Problem Solving $+ b_{18}$Body Monitoring $+ b_{19}$Thoughts & Feelings $+ b_{20}$Association $+ b_{21}$External Surroundings $+b_{22}$Interpersonal Relationships $+b_{23}$Daily Events $+ b_{24}$Spirtual Reflection] $+ [b_{25}$People*time $+ b_{26}$Problem Solving*time $+ b_{27}$Body Monitoring*time $+ b_{28}$Thoughts & Feelings*time $+ b_{29}$Association*time $+ b_{30}$External Surroundings*time $+ b_{31}$Interpersonal Relationships*time $+ b_{32}$Daily Events*time $+ b_{33}$Spirtual Reflection*time].

There exists a possibility that the categories of thoughts are correlated, thus creating multicollinearity in the regression analysis. In order for multicollinearity to occur, the categories must be correlated above r=.85 (Diekhoff, 1992). However, for this data set, the correlations ranged from r=.01 to r=.50, falling well below the r=.85.

For the second regression equation, all the same variables were entered. Subject dummy variables, pre-test mood scores, experimental condition, time of measurement, condition by time interaction and valence. The seventh step entered was level of thinking. This was calculated by taking percentages of level of thinking that were coded as 3, 4, or 5 The final step entered was an interaction of level of thinking with time in order to test for moderator effects. The final regression model was as follows:

$Y = b_0 + [b_1S1 + ... + b_{10}S10] + b_{11}$Pre-test mood scores $+ b_{12}$Condition $+ b_{13}$Time $b_{14}C^*T + b_{15}$Valence $+ b_{16}$Level of Thinking $+ b_{17}$Level of Thinking*Time.

Results

Content of Thoughts

Several t-tests were performed on the heart-rate data recorded at each minute of the exercise bout. There was no significant difference between the heart rates at minutes 18 and 38 indicating that subjects running the free-exercise control were running at 70% of their heart-rate reserve A t-test on RPE confirms this result in that there was again no significant difference between the two conditions.

Category t-tests revealed that the content of 354 thoughts differed for *problem solving* ($t(1,352)=-2.01$, $p<0.05$) and *external surroundings* ($t(1,352)=-2.22$, $p<0.03$). These results indicate that subjects thought more about *problem solving* when doing the 70% run than the control session where the subjects were running at their own pace, but thought more about *external surroundings* in the free session than the 70% session. The results of these t-tests are presented in Table 3.

Insert Table 3 Here

Regression: Relationship Between Content and Level of Thinking

Table 4 presents the results of the regression analysis. The subject dummy variables, experimental condition, time of measurement, and the condition interaction did not explain a significant portion of the variance in *level of thinking*.

Valence accounted for 1.6% of the variance ($R^2=.016$, $F(14,339)=6.87$, $p<.009$). The final b weight, $b=.191$, $p<.03$, indicates that positive valence is related to increases in level of

thinking.

Insert Table 4 Here

The remaining categories were entered as a block and explained 13.5% of the variance (R^2=.135, F(22,331)=8.33, p<.00001). In particular, when subjects thought about *problem solving* (b weight=.285, p<.003), *interpersonal relationships* (b weight=.360, p<.01), and *thoughts and feelings* (b weight=.521, p<.00001), the level of thinking increased. However, when subjects thought about *body monitoring* (b weight=-.293, p<.011), thinking tended to be on a lower level.

Regression: Relationship Between Content and Feeling States

Subject dummy variables. Subject dummy variables accounted for 25.7 to 74.7% of the variance explained in feeling states. Specifically, subject variability was significant for the FS (R^2=.538, F(10,31)=3.61, p<.003), revitalization (R^2=.681, F(10,31) 6.61, p<.00001), and positive engagement (R^2=.747, F(10,31)=9.15, p<.00001). These significant results indicate that individual differences play a role in the perception of feeling states. A summary of the regression analysis is presented in Table 5.

Insert Table 5 Here

Pre-test mood scores. In order to control for differences in feeling states at the onset of the sessions, pre-test mood scores were controlled for early in the regression equation.

The only difference found was that of the tranquility subscale of the EFI (R^2=.089, F(11,30)=4.08), p<.05). However the b weight for pre-test mood scores did not remain significant in the final equation.

Experimental condition. No condition effects were found.

Time of measurement. At the point of entry, time of measurement was significant for mood subscales: FS (R^2=.248, F(13,28)=39.21, p<.00001), tranquility (R^2=.365, F(13,28)=35.41, p<.00001), revitalization (R^2=.132, F(13,28)=24.89, p<.00001), and exhaustion (R^2=.209, F(13,28)=16.42, p<.0004). The final b weights were not significant.

Condition by time, valence, content, content by time interaction. No condition by time, valence, or content effects were found. In addition, no moderator effects were found for content on feeling states.

Regression: Relationship Between Level of Thinking and Feeling States

Subject dummy variables. These were reported in the above analysis. Subject dummy variables were significant for FS, revitalization, and positive engagement. Table 6 presents the results of this regression.

Insert Table 6 here

Pre-test mood scores. As for the first analysis, the only significant pre-test measures were for the tranquility subscale (R^2=.089, F(11,30)=4.08), p<.05). In this case, however, the b weight did remain significant in the final equation, b weight=.580, p<.05, indicating that although many precautions were taken in choosing the subjects and keeping them blind to

hypotheses, some anticipatory effects were present.

Experimental condition. No condition effects were found.

Time of measurement. Time of measurement was significant for the FS, tranquility, revitalization and exhaustion subscales. In this regression, however, the b weights did remain significant indicating an increase in FS (b weight=2.110, $p<.0002$), tranquility (b weight=1.457, $p<.0001$), and revitalization (b weight=.884, $p<.02$). A decrease was observed for exhaustion (b weight=-.665, $p<.04$).

Condition by time, valence, level of thinking. No condition by time, valence, or level of thinking effects were found.

Level of thinking by time. Significant moderator effects were found in the FS ($R^2=.024$, $F(17,24)=3.84$, $p<.06$), tranquility ($R^2=.075$, $F(17,24)$ 8.95, p· .006), and positive engagement ($R^2=.043$, $F(17,24)=6.25$, $p<.02$). Figure 1 illustrates the predicted regression lines for the pre- and post-exercise times. For FS, tranquility, and positive engagement at the pre-exercise measurement time, as favorable moods increased, level of thinking also increased. However, in post exercise, regardless of the level of thinking, the mood was favorable.

Insert Figure 1 here

Discussion

As indicated by the heart-rate data, no differences were found for the intensities of running in the free-exercise control session and the 70% of maximum heart-rate reserve

session. However, subjects reported that they did not like to be controlled while they ran which is somewhat reflected in that they were thinking more about *problem solving* in the 70% session than in the free session. Keeping an eye on the heart-rate monitor watch to maintain the required pace may have been a problem for them. "Oh, it makes me feel a little sort of weird to have this run controlled... it always comes back to an issue of control... now I'm feeling kind of irritated," reported one subject. This quote also demonstrates that *problem solving* induced a higher level of thinking. The fact that this subject recognized that she did not like to be controlled and that this was the source of her irritation is self-reflective in nature and requires introspection on her part. Conversely, when subjects were free to run at their own pace, they thought much more about *external surroundings*. "There's someone throwing a basketball" or "it's a beautiful, sunny day out" were examples of thoughts concerning *external surroundings*. Interestingly, each and every subject had something to say about the weather, indicating that this was omnipresent in their thinking. Perhaps this is due to the harsh winter conditions of the Canadian climate, and should be considered as a separate coding category in future research.

Thoughts and feelings did not differ within conditions, but made up 60% of thought content. This was the highest percentage of all the categories, indicating that these women were pre-occupied with self-reflection. *Thoughts and feelings*, implying self-reflection, self-awareness, and introspection, was also the most significant predictor of *level of thinking*. Examples included: "My mind seems to be going to another consciousness", "I was able to focus more inwardly", and "[...] clears my mind, throws the garbage out".

Body monitoring was another significant predictor of level of thinking in that thoughts

of this nature were related to a lower level of thinking. Examples of *body monitoring* included "my heart rate is at 168" and "my leg hurts when I run in this direction". Interestingly, *associative* thinking was not a significant predictor of *level of thinking*. This result indicates that perhaps research should pay more attention to different types of 'association' much in the same way that definitions of 'dissociation' have become increasingly precise.

Interpersonal relationships were related to higher levels of thinking. Examples of thoughts that fell into the *interpersonal relationships* category included concerns of sibling rivalry in the school setting and the psychological state of an unemployed husband. An example of *people* is "there goes someone in an orange track suit". This category, however, was not a significant predictor of level of thinking, indicating that a *people* thought has to contain a component of involvement rather than a mere an observation of the people in the subject's life.

In sum, the content of thoughts are related to levels of thinking in that subjects attain higher levels of thinking when processing certain thoughts, namely thoughts concerning *problem solving, interpersonal relationships,* and *thoughts and feelings*. Lower levels of thinking were associated with *body monitoring*. However, this was but the first exploratory step in establishing the link between level of thinking and feeling states The subsequent analyses painted a more complete picture of the phenomenon studied.

The purpose of the two remaining regressions was to examine the relationship between content of thoughts and feeling states and level of thinking and feeling states. It was found that level of thinking plays a moderating role. This was shown for the FS, tranquility and positive engagement subscales of the EFI.

Similar to the results of Marco and Suls (1993), subject variability accounted for 25.7 to 74.7% of the variance. There were no differences between the conditions. This is not surprising since the heart-rate data and RPE data showed that the subjects were running at the same intensity throughout both exercise sessions. Both the significant time effects and an examination of the directionality of the b weights suggest that favorable mood increased, as shown through the FS, tranquility, revitalization, and positive engagement. Unfavorable mood, however, decreased as shown through exhaustion.

The two regressions were done in parallel to uncover any relationship between content of thought, level of thinking and mood changes. Through the analysis, it was shown that what individuals were thinking of did not have an impact on their perceived feeling states. Furthermore, the manner in which the individuals were processing the information was not of significance either. A significant moderator effect was found for the more positive subscales of the mood questionnaires indicating that how people process information over time is related to more positive mood states. Specifically, in the pre-exercise condition, higher levels of thinking were related to more favorable mood states, yet post exercise, there was no effect. More favorable mood states were attained regardless of the level of thinking. These results, although not immense, are significant and appealing enough to warrant further probing in future research.

In sum, it was demonstrated through the regressions that content of thought is related to level of thinking and that level of thinking plays a moderating role in regulating selected feeling states. From these results, it would seem that content of thought would also be related to feeling states. However, the data did not support this, as the categories of content of

thought did not explain a significant portion of the variance in feeling states. Therefore, it is likely that the portion of the variance in level of thinking which is explained by thought content is different from the variance which explains the moderating effect on feeling states. Content of thought, specifically, *interpersonal relationships, problem solving, thoughts and feelings* and *body monitoring*, explained 13.3% of the variance in *level of thinking*, whereas the moderating effect of level of thinking explained up to 7.5% of the variance in feeling states. Since the relationship between content of thoughts and feeling states is not statistically significant, it would appear that two different processes are at work.

Future research should include an examination of level of thinking at pre and post exercise to examine in more detail the changes that occur in both content of thoughts and level of thinking with regards to exercise. This could be done by a 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. This discrepancy should be examined in future research.

Similar to studies examining the long-term effects of exercise induced mood, it would also be interesting to examine level of thinking at various points of the day to see how long the effects of exercise last. In addition, manipulating level of thinking during exercise and examining the effects on mood could potentially yield some results in which practitioners could draw some applications. Perhaps if it could be determined at which level of thinking subjects experience the most positive feeling states, more people would remain faithful to their exercise regimens. However, there is much empirical work to be done before we can make such claims.

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Table 1: Summary Statistics (n=11)

Effect	Mean (sd)	Min - Max
Age	32.55(8.31)	22-45
Run, times/week	4.64(1.57)	3-8
Run, min/run	56.82(14.013)	35-90
Run, Distance/week (km)	40.89(21.204)	15-85
Experience (months)	53.27(60.521)	7-216
Other exercise	3.818(1.079)	2-5
HR, rest	68.909(6.818)	58-77
HR, Exercise	151.91(5.56)	144-161

Table 2. Categories and Examples

Category	Example
Valence	I am really happy that the sun is shining today
People	I wonder what my sister is doing right now
Problem solving	I wonder what I will get my mother for her birthday
Body Monitoring	I feel like my lungs are going to burst
Thoughts & Feelings	I feel good today
Associative	My running really makes me feel good
External Surroundings	My that pool looks pretty inviting
Interpersonal Relationships	I like running with her, we talk about our relationships, husbands, and she understands what I am going through
Daily events	I wonder what I will make for dinner
Spiritual reflection	reference to God or supreme being

Please note: one item can be coded into several different categories. For example, the statement: "My feet hurt every time I wear these running shoes. I wonder if they are too small or too narrow or if the cut of the shoe just doesn't suit my foot," can be coded *Body monitoring* because she states that her feet hurt, *Problem solving* because she is wondering what is wrong with the shoe, and *Associative* because she is concerned with her running.

Table 3: Summary of Content of Thoughts (N=354)

Content	% of thoughts Exercise Control	% of thoughts 70% Exercise	% of thoughts Combined
People	27.0	34.4	30.8
Problem Solving	42.5	32.2*	37.3
Body Monitoring	36.3	35.0	35.6
Thoughts & Feelings	60.9	59.4	60.0
Associative	47.7	48.9	48.3
External Surroundings	47.7	36.1*	41 8
Interpersonal Relation.	16.1	12.2	14.1
Daily Events	20.7	22.2	21.5
Spiritual Reflection	0	0	0
Level of Thinking, mean (sd)	1.98(.99)	2.03(.95)	2.0(.96)

* $p<.05$

Table 4 Results of hierarchical regression (content on level of thinking)

Step/Source	Level of Thinking
Cum % (delta %) b weight	
Subject Dummy Variables	**.177(.177)**
Experimental Condition	**.177(.0000)** -.084
Time of Measurement	**.177(.0006)** -.101
Condition by Time	**.181(.003)** 267
Valence	**.197(.016)**** .191*
Content	**.331(.135)*****
Interpersonal Relationships	.360*
Problem Solving	.288**
External Surroundings	-.285
Associative	.204
Thoughts & Feelings	.521***
Daily Events	-.020
Body Monitoring	-.293**
People	-.166
Constant	1.842***
N of concatenated responses	354

* p<.05 ** p<.01 *** p<.001

Table 5. Results of hierarchical analysis (content of thought and mood)

Step/Source **Cum % (delta %)** b weight	**FS**	**EFI** Tranquility	**EFI** Revitalization
Subject Dummy Variables	**.538(.538)****	**.257(.257)**	**.347(.347)**
Pre-Test Mood Scores	**.574(.036)**	**.346(.089)***	**.716(.035)**
Pre-test mood score	967	638	-.128
Experimental Condition	**.574(.00003)**	**.346(.0008)**	**.721(.004)**
70% vs Free	.024	-.084	- 603
Time of Measurement	**.823(.248)*****	**.711(.365)*****	**.852(.131)*****
Post vs Pre	-.529	1 546	2 326
Condition by Time	**.823(.0005)**	**.721(.010)**	**.852(.00009)**
C X T	.179	-.127	112
Valence	**.824(.0006)**	**.725(.004)**	**.857(.005)**
Positive valence	.037	.011	-.001
Content	**.842(.018)**	**.741(.016)**	**.866(.009)**
Daily Events	011	.011	- 015
Body Monitoring	-.013	.006	.004
Interpersonal Relation	.020	.004	-.002
External Surroundings	.007	.013	-.017
Problem Solving	-.0007	- 002	- 011
People	-.034	- 011	- 006
Associative	.023	.001	tol
Thoughts & Feelings	tol	tol	tol
Content by Time	**.929(.087)**	**.836(.095)**	**.890(.024)**
Interpersonal Relation X T	-.019	- 020	.0009
Daily Events X T	-.031	- 014	- 002
Body Monitoring X T	-.014	-.006	-.011
People X T	042	029	- 013
External Surroundings X T	.018	- 004	- 002
Problem Solving X T	.019	- 002	008
Thoughts & Feelings X T	.012	.0008	-.011
Associative X T	.001	.004	-.005
Constant	-1.05	- 563	3.43
N of concatenated responses	42	42	42

* p<.05 ** p<.01 *** p<.001

Table 5 (continued): Results of hierarchical analysis (content of thought and mood).

Step/Source **Cum % (delta %)** b weight	**EFI** Positive Eng.	**EFI** Exhaustion
Subject Dummy Variables	**.747(.747)*** **	**.347(.347)**
Pre-Test Mood Scores	**.758(.011)**	**.427(.081)**
Pre-test mood score	.825	.526
Experimental Condition	**.759(.001)**	**.435(.008)**
70% vs Free	-.133	.030
Time of Measurement	**.773(.014)**	**.644(.209)*** **
Post vs Pre	2.14	-2.268
Condition by Time	**.779(.006)**	**.652(.008)**
C X T	- 502	-.234
Valence	**.787(.008)**	**.663(.010)**
Positive valence	.017	-.011
Content	**.800(.013)**	**.685(.023)**
Daily Events	- 002	-.002
Body Monitoring	- 001	.003
Interpersonal Relation	-.010	-.016
External Surroundings	-.009	.005
Problem Solving	tol	.009
People	-.013	- 002
Associative	.011	- 022
Thoughts & Feelings	tol	tol
Content by Time	**.902(.102)**	**.831(.146)**
Interpersonal Relation X T	-.003	.017
Daily Events X T	-.0008	-.002
Body Monitoring X T	-.008	.014
People X T	.002	.033
External Surroundings X T	-.003	.001
Problem Solving X T	.008	-.014
Thoughts & Feelings X T	-.023*	-.005
Associative X T	.002	.019
Constant	.194	1.180
N of concatenated responses	42	42

* p< 05 ** p<.01 *** p<.001

Table 6: Results of hierarchical analysis (level of thinking and mood).

Step/Source Cum % (delta %) b weight	FS	EFI Tranquility	EFI Revitalization
Subject Dummy Variables	**.538(.538)****	**.259(.257)**	**.681(.681)*****
Pre-Test Mood Scores	**.574(.036)**	**.346(.089)***	**.716(.035)**
Pre-test mood score	.426	580*	461*
Experimental Condition	**.574(.00003)**	**.346(.0008)**	**.721(.004)**
70% vs Free	-.263	- 369	- 558
Time of Measurement	**.823(.248)*****	**.711(.365)*****	**.852(.131)*****
Post vs Pre	2 11***	1 457***	884*
Condition by Time	**.823(.0005)**	**.721(.010)**	**.852(.00009)**
C X T	.131	341	045
Valence	**.824(.0006)**	**.725(.004)**	**.857(.005)**
Positive valence	.012	013	024
Level of Thinking	**.825(.002)**	**.725(.0002)**	**.864(.007)**
High vs Low	017	011	.010
Level of Thinking X Time	**.849(.024)***	**.800(.075)****	**.864(.0003)**
Level X T	-.021*	-.020**	- 002
Constant	- 034	262	183
N of concatenated responses	42	42	42

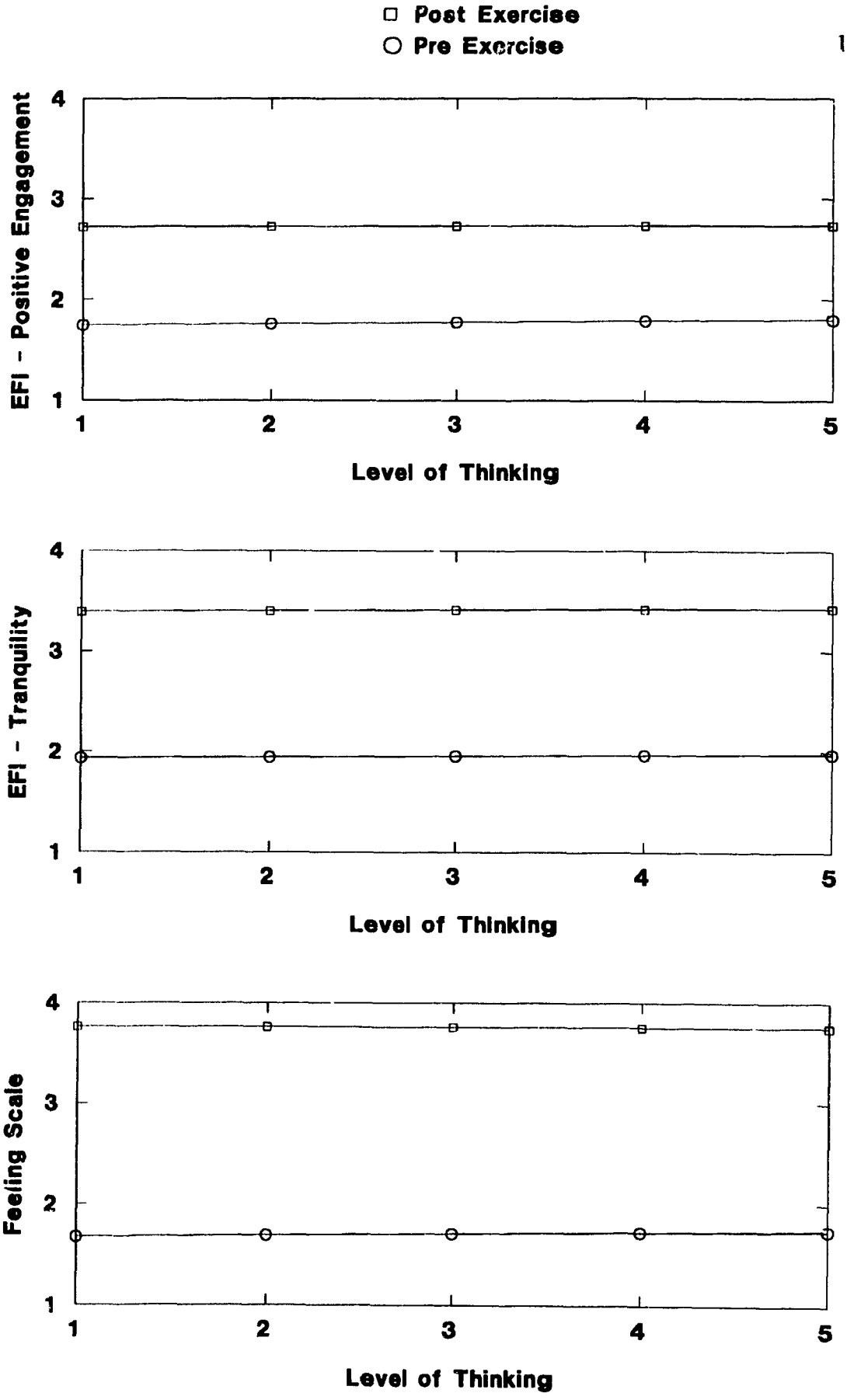
* p<.05 ** p<.01 *** p< 001

Table 6 (continued) Results of hierarchical analysis (level of thinking and mood).

Step/Source **Cum % (delta %)** b weight	**EFI** Positive Eng	**EFI** Exhaustion
Subject Dummy Variables	**.747(.747)*** **	**.347(.347)**
Pre-Test Mood Scores	**.758(.011)**	**.427(.081)**
Pre-test mood score	540	.397
Experimental Condition	**.759(.001)**	**.435(.008)**
70% vs Free	-.303	-.0005
Time of Measurement	**.773(.014)**	**.644(.209)*** **
Post vs Pre	990**	-.665*
Condition by Time	**.779(.006)**	**.652(.008)**
C X T	-.347	251
Valence	**.787(.008)**	**.663(.010)**
Positive valence	.024	-.016
Level of Thinking	**.791(.003)**	**.666(.010)**
High vs Low	.015	- 002
Level of Thinking X Time	**.834(.043)***	**.670(.003)**
Level X T	- 019*	-.003
Constant	.194	794
N of concatenated responses	42	42

* p< 05 ** p< 01 *** p< 001

Figure 1: Predicted lines of the Level of Thinking moderator variables on the Feeling Scale, the Positive Engagement and Tranquility subscales of the EFI.


□ Post Exercise
○ Pre Exercise
EFI - Positive Engagement
4
3
2
1
1
2
3
4
5
Level of Thinking
EFI - Tranquility
4
3
2
1
1
2
3
4
5
Level of Thinking
Feeling Scale
4
3
2
1
1
2
3
4
5
Level of Thinking

General Conclusion

General Conclusion

The primary purpose of this dissertation was to identify gaps in the literature on the psychosocial outcomes of exercise. It was found that although much work has been done examining the effects of exercise on the alleviation of depression and anxiety, which are negative psychological states, little attention has been devoted to the effects of exercise on emotional well-being. In addition, while researchers have recognized that individual difference variables are important, there is a dearth in the literature examining the moderating role of these variables.

One of these individual difference variables is ongoing thoughts during exercise. Researchers have long been fascinated with the effects of association and dissociation (i.e. thoughts about physical sensations and thoughts other than physical sensations) on sport performance. This concept has evolved from a two-factor model into a multi-factor model as it has gained popularity. Recently, researchers have begun to examine the potential impact that these thoughts have on feeling states (Goode & Roth, 1993). Although promising, methodological shortcomings have prevented researchers from drawing strong conclusions.

In light of these conceptual and methodological limitations, alternative research strategies were presented. Specifically, a rationale for the study of emotional intelligence and level of thinking was established. Emotional intelligence was defined as the ability to pay attention to mood, to clearly perceive mood, and to maintain or repair mood. Level of thinking is the ability to think introspectively and demonstrate self-awareness. It was hypothesized that meta-mood cognitions and abilities as well as level of thinking during exercise would moderate pre- to post-exercise changes in mood and feeling states.

Thus, the purpose of the two studies was to explore the moderating role of ongoing thoughts during exercise and their impact on pre- to post-exercise changes in mood and feelings states. This was achieved through the use of alternative research strategies. In the first study, it was found that neither meta-mood cognitions nor meta-mood abilities were directly related to feeling states. However, results showed that selected meta-mood abilities play a moderating role in energy. Specifically, the more individuals were able to pay attention to their mood and the higher their ability to repair it, the higher the perceived energy states. This result was demonstrated for the post-exercise condition. Conversely, in the pre-exercise, pre-attention control and post-attention control conditions, lower levels of perceived energy were observed in individuals with higher meta-mood abilities.

In the second study, the phenomenon at work was further probed. A direct measurement of ongoing thoughts during exercise was taken using the *Stream-of-Consciousness* methodology. By coding the content of the thoughts into different categories, it was hoped that a relationship between pattern of thinking and positive changes in feeling states would emerge. It was found that certain thoughts, namely thoughts about *body monitoring, thoughts and feelings, interpersonal relationships,* and *problem solving*, were successful predictors of level of thinking. In addition, while level of thinking did not have a direct relationship with feeling states, a moderating role was established indicating that higher level of thinking is related to higher levels in the Feeling Scale, Positive Engagement and Tranquility. Since content of thought is related to level of thinking and level of thinking is related to changes in feeling state, it would be logical to assume that the content of thoughts would be somewhat related to impact on feeling states. Unfortunately, this relationship was

not established. It would seem that the variance explained in level of thinking by thought content is not shared by the variance in level of thinking that predicts feeling states. Perhaps other unexplored moderating variables explain differing portions of the variance.

In the two studies presented in this dissertation, it was found that trait meta- mood and level of thinking play a moderating role in the perception of feeling states. Although the research methodologies employed in these two studies were quite different, meta-mood cognitions and level of thinking may be conceptually related. An individual who has high trait meta-mood abilities is capable of repairing undesired mood, paying attention to the mood, and clearly perceiving the mood. As the word 'meta' implies, trait meta-mood is the ability of the subject to stand back or remove himself from the situation and evaluate the ongoing mood. A person who is capable of achieving a high level of thinking is able to demonstrate a certain amount of self-reflectiveness, self-awareness, and introspection. In other words, high-level thinking is the ability to go beyond what is felt at the particular moment. Thus, both these concepts may be related because they both require a removal from and evaluation of mood.

While the relationship between meta-mood abilities and level of thinking established, attention must be given to their relationship to exercise. It was found through the reviewed literature on association/dissociation that thoughts during running were related to performance and perceived exertion. Specifically, associative thinking was related to higher perceived exertion. Moreover, successful marathoners used associative thinking when verifying energy reserves and dissociation when faced with a difficult portion of the course. None of these studies examined feeling states during any portion of their running. In fact, Sachs (1984), in his manipulation of cognitive strategies, briefly mentioned that subjects

required to think in a manner they were not accustomed to did not like the procedure very much and were happy when the study requirements were over. Therefore, thoughts during running probably do have an impact on subsequent feeling states. Supporting this idea, the research conducted as part of this dissertation does indicate that thoughts play a moderating role in the perception of feeling states.

With regards to the studies conducted, many of the conceptual and methodological limitations highlighted in the review of literature were addressed. First, in-task data were used instead of retrospective data, thus eliminating biases related to the recall of actual mood. Second, the aggregate of categories used in the analysis of the second study is conceptually driven instead of data driven. I do recognize, however, that data collected can and must serve to further refine the categories. Third, the periodically collected heart-rate data and the Exercise Behavior Questionnaire (Godin, Jobin & Bouillon, 1986) served as manipulation checks to verify that the subjects categorized as fit-active or unfit-inactive did indeed belong to those groups and that subjects were cycling and running at the prescribed intensities. These data also insured that the subject sample was homogeneous with regards to subjects' exercise experience and level of fitness.

As explained previously, while the results of the research are statistically significant they are by no means overwhelming and only answer certain research questions Furthermore, they introduce a whole new set of questions. First, in the study on meta-mood cognitions, only selected changes were found in exercise-induced mood. This led to the conclusion that perhaps more exercise-specific and sensitive research instruments are warranted. This need was partially resolved in that the Exercise-Induced Feeling Inventory

(EFI, Gauvin & Rejeski, 1993) was employed in the study on level of thinking. Second, the results of the first study highlighted the need for more sensitive instruments in detecting meta-mood changes. The *Stream-of-Consciousness* methodology is one method which can be used in further probing the thoughts that subjects may entertain while exercising. However, the EFI and *Stream-of-Consciousness* methodology have their limitations as well. For instance, the EFI, although exercise specific, is still a new research instrument and more empirical data must be collected. The *Stream-of-Consciousness* methodology, while a viable tool in measuring thoughts is subjective in its analysis and thus, thought categories must be refined.

In sum, this dissertation presented an overview of the pertinent literature concerning thoughts during exercise. In addition, the research attempted to use alternative methodologies in investigating individual difference variables which may moderate the perception of feeling states. Unfortunately, the results preclude us from drawing many practical applications. However, this research does provide us with a foundation on which to build future research.

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Appendix A:

Consent Forms

CONSENT FORM

Project Title: The effects of different physical activities on subjective well-being

Purpose: Research conducted in partial fulfilment of Ph.D , Special Individual Program, Concordia University

Principal Investigator: Ann O'Halloran, MSc
Ph D candidate
Department of Graduate Studies, Concordia University

Thesis Supervisor: Lise Gauvin, Ph D
Department of Exercise Science, Concordia University

The project identified above is designed to examine the effects of different activities on people's thoughts and feelings

Your involvement in the project will consist of filling out a questionnaire in order to identify certain personal characteristics. Based on the results of all participants, a smaller number of individuals will be invited to participate in the second phase of the study This will consist of three sessions lasting about one hour each In each session, you will be asked to do some activity as well as answering various questionnaires on your well-being throughout the activity Each session will be scheduled at your convenience within a three week period

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 kept confidential as only averages and standard deviations will be reported 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 accept to participate, please fill out the bottom portion of this form If you have any questions regarding the project, I can be reached at the following number

Ann O'Halloran, MSc , Dr Lise Gauvin, Dept of Exercise Science, 848-3321

I, _____ have read the paragraphs explaining the nature and procedures of the study conducted by Ann O'Halloran, Ph.D candidate, under the supervision of Dr Lise Gauvin and I hereby consent to participate in the above-mentioned study realizing that I am free to discontinue participation at any time

Signature_____
Date_____

CONSENT FORM

Project Title: The relationship between different conditions of running and thoughts.

Purpose: Research conducted in partial fulfilment of the Ph.D degree, School of Graduate Studies, Concordia University

Principal Investigator: Ann O'Halloran, MSc
Ph D candidate
School of Graduate Studies, Concordia University

Thesis Supervisor: Lise Gauvin, Ph.D
Department of Exercise Science, Concordia University

The project identified above is designed to examine the relationship between different conditions of running and people's thoughts

Your involvement in the project will consist of filling out a series of questionnaires during a running session to identify what you are thinking and feeling at various moments throughout a running session. Specifically, this study will consist of three sessions lasting about one hour each In each session, you will be asked to do some running, answer various questionnaires, and speak into a tape-recorder about your thoughts throughout the activity. Each session will be scheduled at your convenience

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 accept 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

Ann O'Halloran, MSc , Dr Lise Gauvin, Dept of Exercise Science 848-3321

I, _____ have read the paragraphs explaining the nature and procedures of the study conducted by Ann O'Halloran, Ph D candidate, under the supervision of Dr. Lise Gauvin and I hereby consent to participate in the above-mentioned study realizing that I am free to discontinue participation at any time

Signature _____
Date _____

Appendix B:

Summary of Procedures

Experiment 1:

Session 1:

Fill out the consent form and the PAR-Q.

Pre-test measures: Listening to new-age music for 5 minutes.
Fit subject with sport-tester.
Take resting heart rate.
Fill out the PANAS, FS, AD-ACL, and SMMS.

Experimental procedure:

Time 0: Subject is given some magazines to read.

Time 20: Subject is asked the PANAS, FS, AD-ACL, and SMMS. Subject resumes reading.

Time 30: Subject is asked the PANAS, FS, AD-ACL, and SMMS.

Time 35: Submaximal VO_2 test is given.

Sessions 2 & 3 (counterbalanced):

Pre-test measures: Listening to new-age music for 5 minutes.
Fit subject with sport-tester.
Fill out the PANAS, FS, AD-ACL, and SMMS.

Experimental procedure:

Time 0: Subject begins cycling and the tension is gradually moved so that she is exercising at 30% (70%) of heart rate reserve.

Time 20: Subject is asked the PANAS, FS, AD-ACL, RPE, and SMMS. Subject is cycling while questionnaires are administered.

Time 30: Subject stops cycling and is asked the PANAS, FS, AD-ACL, and SMMS.

Time 60: Subject is asked the PANAS, FS, AD-ACL, and SMMS. Subject leaves the lab with a copy of the PANAS, FS, AD-ACL, and SMMS to be filled out in one hour. Session 3's set of questionnaires also contains the TMMS.

Experiment 2:

Sessions 1, 2, & 3 (counterbalanced)

Fill out the consent form (Session 1 only)

Pre-test measures: Listening to new-age music for 5 minutes.
Fit subject with sport-tester.
Take resting heart rate. (Session 1 only)
Speak for 5 minutes into recorder.
Fill out the EFI, and FS.

Experimental procedure:

Time 0:	Subject begins to run.
Time 15:	Subject is asked to speak into the recorder while running.
Time 20:	Subject is asked the EFI, FS, RPE, and SIM. Subject resumes running.
Time 35:	Subject is asked to speak into the recorder while running.
Time 40:	Subject is asked the EFI, FS, RPE, and SIM. Subject resumes running.
Time 70:	When heart rate is + or - 10 beats of resting heart rate, subject is asked to speak into the recorder. After the 5 minutes is complete, the subject is asked the EFI and FS.

Appendix C:

Activation-Deactivation Adjective Check List

Please use the following rating scale to describe your feelings at this moment. Place a number in the blank line next to each statement.

1 = definitely feel
2 = feel slightly
3 = cannot decide
4 = definitely do not feel

_____ 1. Active
_____ 2. Placid
_____ 3. Sleepy
_____ 4. Jittery
_____ 5. Energetic
_____ 6. Intense
_____ 7. Calm
_____ 8. Tired
_____ 9. Vigorous
_____ 10. At-rest
_____ 11. Drowsy
_____ 12. Fearful
_____ 13. Lively
_ _ 14. Still
_____ 15. Wide-awake
_____ 16. Clutched-up
_____ 17. Quiet
_____ 18. Full-of-pep
_____ 19. Tense
_____ 20. Wakeful

Appendix D:

Exercise Behavior Questionnaire

Over the past 4 months, how many times have you exercised on average?

____ 1. None

_____ 2. Less than once a month

_____ 3. About once a month

_____ 4. About 2 or 3 times a month

_____ 5. About 1 or 2 times a week

_____ 6. 3 times a week or more

Appendix E:

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 not, 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 F:

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 G:

Positive Affect Negative Affect Schedule

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 not, that is, at the present moment. Use the following scale to record your answers.

1 = very slightly or none at all
2 = a little
3 = moderately
4 = quite a bit
5 = extremely

_____ 1. Interested
_____ 2. Distressed
_____ 3. Excited
_____ 4. Upset
_____ 5. Strong
_____ 6. Guilty
_____ 7. Scared
_____ 8. Hostile
_____ 9. Enthusiastic
_____ 10. Proud
_____ 11. Irritable
_____ 12. Alert
_____ 13. Ashamed
_____ 14. Inspired
_____ 15. Nervous
_____ 16. Determined
_____ 17. Attentive
_____ 18. Jittery
_____ 19. Active
_____ 20. Afraid

Appendix H:

Rate of Perceived Exertion

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

6
7 Very, very light
8
9 Very light
10
11 Fairly Light
12
13 Somewhat hard
14
15 Hard
16
17 Very hard
18
19 Very, very hard

How hard are you working right now? _____

Appendix I:

Similarity to Regular Perceived Exertion Questionnaire

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

Not at all similar	Somewhat similar	Similar	Very similar	Identical
1	2	3	4	5

How similar is this level of exertion to your preferred level of exertion?

Appendix J:

State Meta Mood Scale

Please read each statement and decide whether or not you agree with it. Place a number in the blank line next to each statement using the following scale:

4 = agree
3 = somewhat agree
2 = somewhat disagree
1 = disagree

_____ 1. I know this mood will change soon

_____ 2. I am able to describe my present mood

_____ 3. This is a very typical mood for me

_____ 4. When I am in such good moods I think good thoughts

_____ 5. My mood feels as if it will never change

_____ 6. I know I shouldn't feel this way

_____ 7. I almost never feel this way

_____ 8. There is nothing wrong with feeling the way I do

_____ 9. Mood has changed my outlook on life

_____ 10. My present mood is strange or bizarre

_____ 11. I am doing something to change my mood

_____ 12. I know exactly how I'm feeling

_____ 13. The way I feel now is fine with me

_____ 14. This mood, too, shall pass

_____ 15. I think good thoughts to cheer up

_____ 16. Mood is so strong, thinking isn't sensible

_____ 17. I experience mood without changing it

_____ 18. I am scared by how I feel

_____ 19. Mood is in response to very real situations

_____ 20. My feelings are out of control

_____ 21. It is hard for me to tell what my mood is right now

_____ 22. It seems as if my mood will go on forever

_____ 23. I can't tell what my emotions are

_____ 24. I am unable to describe how I am feeling

_____ 25. I feel this way a lot

Appendix K:

Trait Meta Mood Scale

Please read each statement and decide whether or not you agree with it. Place a number in the blank line next to each statement using the following scale:

5 = strongly agree
4 = somewhat agree
3 = neither agree nor disagree
2 = somewhat disagree
1 = strongly disagree

_____ 1. The variety of human feelings makes life more interesting.

_____ 2. I try to think good thoughts no matter how badly I feel.

_____ 3. I don't have much energy when I'm happy.

_____ 4. People would be better off if they felt less and thought more.

_____ 5. I usually don't have much energy when I'm sad.

_____ 6. When I'm happy, I usually let myself feel that way.

_____ 7. I don't think it's worth paying attention to your emotions or moods.

_____ 8. I don't usually care much about what I'm feeling.

_____ 9. Sometimes I can't tell what my feelings are.

_____ 10. If I find myself getting mad, I try to calm myself down.

_____ 11. I have lots of energy when I feel sad.

_____ 12. I am rarely confused about how I feel.

_____ 13. I think about my mood constantly.

_____ 14. I don't let my feelings interfere with what I'm thinking.

_____ 15. Feelings give direction to life.

_____ 16. Although I am sometimes sad, I have a mostly optimistic outlook.

_____ 17. When I am upset I realize that the "good things in life" are illusions.

_____ 18. I believe in acting from the heart.

_____ 19. I can never tell how I feel.

_____ 20. When I am happy, I realize how foolish most of my worries are.

_____ 21. I believe it's healthy to feel whatever emotion you feel.

_____ 22. The best way for me to handle my feelings is to experience them to the fullest.

_____ 23. When I become upset I remind myself of all the pleasures in life

_____ 24. My beliefs and opinions always seem to change depending on how I feel.

5 = strongly agree
4 = somewhat agree
3 = neither agree nor disagree
2 = somewhat disagree
1 = strongly disagree

25. I usually have lots of energy when I'm happy.
26. I am often aware of my feelings on a matter.
27. When I'm depressed, I can't help but think of bad thoughts.
28. I am usually confused about how I feel.
29. One should never be guided by emotions.
30. If I'm in too good a mood, I remind myself of reality to bring myself down.
31. I never give in to my emotions.
32. Although I am sometimes happy, I have a mostly pessimistic outlook.
33. I feel at ease about my emotions.
34. It's important to block out some feelings in order to preserve your sanity.
35. I pay a lot of attention to how I feel.
36. When I'm in a good mood, I'm optimistic about the future.
37. I can't make sense out of my feelings.
38. I don't pay much attention to my feelings.
39. Whenever I'm in a bad mood, I'm pessimistic about the future.
40. I never worry about being in too good a mood.
41. I often think about my feelings.
42. I am usually very clear about my feelings.
43. No matter how badly I feel, I try to think about pleasant things.
44. Feelings are a weakness humans have.
45. I usually know my feelings about a matter.
46. It is usually a waste of time to think about your emotions.
47. When I am happy, I sometimes remind myself of everything that could go wrong.
48. I almost always know exactly how I'm feeling.