Variability in the Affective Exercise Experience of Low-active Women: Exploring the Role of Cognitive Appraisal During Exercise.

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Abstract

A popular avenue of research in the field of exercise psychology in recent years has been the exploration of affective responses to acute exercise. However, there has been little research into the affective experiences of habitually low-active women during exercise and the mechanisms that govern these responses. This is surprising given the current high rates of inactivity amongst women and the potential importance of affective associations for volitional behaviour. In addition, this area of research has been hindered by methodological inconsistencies and limitations, which are arguably the reasons behind indefinite evidence of a dose-response relationship between exercise and affect (Ekkekakis & Petruzzello, 2000). The studies presented in this thesis were designed to investigate affective responses to exercise in low-active females from a holistic perspective. Specifically, the dual-model model (Ekkekakis, 2003) was employed as a theoretical framework, and the research sought to take into consideration the methodological concerns associated with previous studies.

The first study, a pilot investigation, demonstrated widespread interindividual variation in inactive female's affective responses during both high and low intensity exercise bouts. Study two was designed to investigate the affective responses of twenty low-active females throughout an incremental exercise test to volitional exhaustion, relative to metabolic demarcations of exercise intensity. Results of this study indicated that even though participants' affective valence improved from pre- to post-exercise, a mean decline began before the ventilatory threshold (VT) was reached (i.e., during 'moderate' intensity exercise). Study three manipulated twenty-four low-active female participants' perceptions of exercise duration to test the influence of cognitive appraisal of the task upon affective responses during 'moderate' intensity exercise (i.e., at 90% VT), and the temporal relationship between self-efficacy and affect during exercise. Again, participants were more positive post-exercise than pre-exercise, but a progressive decline in affective valence during exercise was also observed that was more pronounced when participants were unaware of the exercise duration. Furthermore, the results of this study indicated that self-efficacy perceptions explained substantial variance in affective valence during exercise. This relationship was stronger for self-efficacy measured during exercise than before exercise, and when exercise duration was unknown compared to known. In the final study, six women who participated in both studies two and three were interviewed about their experiences of the exercise bouts they completed. A range of experiences were captured in narrative profiles and paired with quantitative data in order to comprehensively explore interindividual variability from the participants' perspectives. As a result, specific sources of self-efficacy and affect during exercise were identified.

Overall, the results presented in this thesis revealed that even though low-active women felt better after exercise, affective valence during exercise declined as intensity increased. Also, a substantial amount of interindividual variance at 'moderate' intensity could be explained by cognitive appraisal factors, particularly self-efficacy perceptions during exercise. By utilising metabolic demarcations to accurately define exercise intensity, this research advocates the importance of a mind-body approach in exercise psychology research. This distinction, along with the mixed quantitative-qualitative methodology that was employed, enabled detailed exploration of individual differences in the exercise experience and highlighted important avenues for future research. Theoretical consequences of the research are discussed throughout the thesis, as are the practical implications this research has for effective exercise prescription with inexperienced female exercisers.

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Chapter One: Introduction and Literature Review

Background

In a recently published strategy document, the Department of Culture Media and Sport (DCMS, 2002) stated that the benefits of physical activity on health are clear, well evidenced and widely accepted: 30 minutes of moderate activity five times a week can help to reduce the risk of cardiovascular diseases, some cancers, strokes and obesity. Substantial evidence is rapidly accumulating to indicate that regular physical activity can also have a profound influence on psychological well-being, and more calls are being made to consider exercise as a therapy for mental health problems (Stathopoulou, Powers, Berry, Smits, & Otto, 2006; Callaghan, 2004). However, it has been estimated that at least 60% of the global population fails to achieve the minimum recommendation of thirty minutes a day of moderate-intensity physical activity (World Health Organisation; WHO, 2004).

The most recent national health survey in England indicated that 37% of men and only 25% of women meet these recommendations, with 35% of men and 41% of women classed as low-active (i.e., achieve less than 30 minutes of physical activity per week; Joint Health Survey; JHS, 1999). More recently, results of a smaller survey suggested that only 24% of men and 18% of women in England take part in moderate intensity sport and active recreation for at least 30 minutes continuously in any one session on at least three days a week (Sport England, 2006[1]). Whilst this discrepancy may be due to a smaller sample size in the second study, it may also be indicative of a drop in physical activity rates in the last decade. Irrespective of what the exact numbers are, one thing appears to be certain: women are less likely to lead a physically active lifestyle than men are. In light of these statistics it is perhaps unsurprising that the DCMS (2002) revealed that obesity levels in England have tripled in the past two

[1] 239 different sports and recreational activities were counted in the survey, including recreational walking and cycling.

decades. Furthermore, the DCMS (2002) has estimated that total cost to England of physical inactivity to be at least £2bn a year, which represents about 54,000 lives lost prematurely. As a consequence of this startling evidence, physical activity has recently been identified as 'the new imperative for public health' (Sparling, Owen, Lambert, & Haskell, 2000).

The evidence in favour of the benefits of physical activity is great and the consequences of inactivity are even greater. Yet large numbers of people fail to engage in enough physical activity to achieve the health benefits. As Thayer (2001. p. 32) remarked, "the extensive evidence about the value of exercise should have the gyms packed, the running tracks crowded, and the sidewalks filled with throngs of people walking. But they aren't." In addition, approximately 50% of those who begin an exercise programme are believed to drop out within the first six months (Dishman & Buckworth, 1997). These statistics paint a worrying picture and expose the complexity of the problem facing exercise and health professionals today. With widespread awareness amongst the general public of the physical benefits of a physically active lifestyle, we need to ask why people are still not exercising enough.

The central concept of most current health behaviour models (e.g., the health belief model, Rosenstock, 1974; theory of planned behaviour, Ajzen, 1985) is that individuals engage in a rational 'cost-benefit' analysis of behavioural choices, and then select the course of action with the most favourable benefit:cost ratio (Weinstein, 1993). In addition, much of the research that has been conducted in an attempt to understand decisions made about physical activity behaviour has focused upon cognitive, behavioural and environmental variables (e.g., see Trost, Owen, Bauman, Sallis, & Brown, 2002; Humpel, Owen, & Leslie, 2002). For example, behaviourist notions of learning focus on observable and instrumental consequences of behaviour (e.g., Skinner, 1938). However, another aspect that may play a significant role in people's decisions to adhere (or not) to exercise programmes is how the physical activity makes them feel *whilst* they engage in it. This viewpoint is embedded in hedonic theory, which focuses on affective responses (i.e., pleasure/displeasure, or the 'good/bad dimension') to behaviour as determinants of future behaviour (Kahneman, 1999) and has, until recently, received little attention in physical activity contexts (e.g., Williams, Dunsiger, Ciccolo, Lewis, Albrecht & Marcus, in press; Kiviniemi, Voss-Humke & Seifert, 2007; Ekkekakis, Hall & Petruzzello, 2005a).

Hedonic Theory

Hedonic psychology is the study of what makes experiences and life pleasant or unpleasant. Although it is considered a relatively new field of psychology (Kahneman, Diener & Shwartz, 1999), a great deal of the supporting research is much more mature (e.g., Cabanac, 1971; Young, 1959). In fact, the notion that hedonic mechanisms might provide direction to behaviour can be traced back to the Ancient Greek philosophers (e.g., Epicures; Bozarth, 1994). From a physiological perspective, Cabanac (1971, 1992) argued that hedonic responses (i.e., pleasure versus displeasure) provide an index of the usefulness of behaviour and its immediate outcomes relative to existing internal states, and that humans will therefore seek out all pleasant stimuli and avoid unpleasant stimuli. Kahneman and Riis (2005) suggested that one makes decisions about future behaviour based upon evaluative memories of previous affective experiences of the behaviour.

There is additional evidence to suggest that that people's global evaluations of past affective episodes can be well predicted by the affect experienced during just two moments: the moment of peak affect intensity and the ending (Fredrickson, 2000). This concept, known as the "peak and end rule", further suggests that the duration of affective episodes is largely neglected when individuals are making choices about future behaviour based upon previous experience. For example, in order to test this concept

Kahneman, Fredrickson, Schreiber and Redelmeier (1993) asked participants to put one hand in 14°C water for 60 seconds and (on a separate occasion) the other hand in 14°C water for 60 seconds immediately followed by 30 seconds during which the temperature of the water was raised to 15°C. When given the choice of which trial to repeat a significant majority chose to repeat the longer trial. This concept, when applied to an exercise context, suggests that the experience at the end of an exercise bout could be a significant predictor of future exercise behaviour, irrespective of exercise duration. Brewer, Manos, McDevitt, Cornelius and Van Raalt (2000) found some evidence to support this notion when they demonstrated that participants reported a 15 min cycling bout of increasing exertion as more aversive than an exercise bout that involved the same 15 min of increasing exertion followed by a 5 min period of reduced exertion. Whether these differences in observed aversiveness between these exercise bouts with different 'ends' transfer over to predict future exercise behaviour, however, is yet to be directly investigated.

Whatever mechanisms may be responsible, there is substantial evidence from health psychology research to suggest that humans have a tendency to seek out pleasurable situations and avoid displeasurable ones. It has been consistently demonstrated that the affect experienced in a situation is a strong predictor of the amount of time people subsequently choose to spend in that situation (e.g., Emmons & Diener, 1986), and whether or not people choose to repeat the behaviour (e.g., Kahneman, Fredrickson, Schreiber & Redelmeier et al, 1993; Redelmeier & Kahneman, 1996). Some support for these phenomena in a physical activity context was found when a recent study demonstrated that the level of affect experienced at 'moderate' exercise intensity (≥ 64% age-predicted maximal heart rate) predicted self-reported physical activity participation 6 and 12 months later (Williams et al., in press). In addition, Annesi (2005) identified that women's attendance during a 12 week (3 sessions per week) exercise programme was positively related to changes in revitalization ($r = .28$) and negatively related to changes in exhaustion ($r = .28$) pre- to post-post exercise. Indeed, it would appear essential that the nature of affective responses to exercise be investigated in more detail if we are to gain more insight into the adherence problems associated with physical activity programmes (Van Landuyt, Ekkekakis, Hall & Petruzzello, 2000).

Lack of Consensus on the Exercise Intensity-Affect relationship

Research into the relationship between acute exercise and psychological outcomes has been at the forefront of exercise psychology research for over three decades. Of particular interest has been the notion that an optimal dose (e.g., exercise mode, intensity, duration) of exercise may exist that induces positive psychological responses (Ekkekakis & Petruzzello, 1999; 2000). As a consequence, a number of researchers have attempted to draw conclusions about a relationship between aerobic exercise dose and affective responses. For example, Raglin and Morgan (1985) recommended that the intensity must be at 60% of maximal aerobic power ($\dot{V}O_2$ max), and Dishman (1986) proposed that exercise intensity must be at least 70% $\dot{V}O_2$ max and 20 min in duration to obtain affective benefits. More recently, Morgan (1997) claimed that 70% $\dot{V}O_2$ max can be used as an exercise prescription for all individuals. Although a precise dose is still the matter of some debate, until recently reviewers were largely unanimous in their conclusion that, for most people, aerobic exercise is associated with increases in positive mood and generally makes you 'feel better' (e.g., Landers & Arent, 2001; Yeung, 1996). This perspective, that acute exercise induces a 'feel-good factor', has also been popularised by the media representation of a 'runner's high'.

However, from the perspective of hedonic theory these synopses conflict with the evidence that few people lead physically active lifestyles. Ekkekakis and

Petruzzello's (1999) review revealed that the majority of studies have focused upon changes in affect pre- to post-exercise, and fewer investigations have investigated participants' perceptions of affect *whilst* they exercise. Results of studies that investigated during-exercise affective responses were much less conclusive. Ekkekakis and Petruzzello (1999) argued that the literature is abundant with inconsistent methodologies and that this could serve to explain some of the contradictory results that have pervaded the exercise-affect literature. In addition to the timing of affect measurement, the methods used to define exercise intensity and the measures used to assess affect were also diverse. It was suggested that the literature actually provides evidence against generalisation and in favour of further investigation of individual differences.

Many literature reviews exist (e.g., Gauvin & Spence, 1996; Ekkekakis & Petruzzello, 1999; Landers & Arent, 2001; Reed & Ones, 2006) that have effectively examined the extensive research on the relationship between acute exercise and affective responses from a dose-response perspective. To do so again would be repetitive and unnecessarily protracted. Readers are therefore referred to Ekkekakis and Petruzzello (1999) and Reed and Ones (2006) for comprehensive recent reviews of the literature. Instead, the following review will briefly outline some key theoretical and methodological issues with previous studies, detailing selected studies as illustrative examples. These issues were identified by Ekkekakis and Petruzello (1999; 2000) as potential contributors to the lack of consensus on a dose-response relationship. Detailed analysis of specific exercise-intensity/affect studies will be retained for more recent investigations that have differed conceptually and methodologically from past research, and which have enabled considerable progress to be made in the quest to understand the nature of affective responses to exercise.

Definition of Terms

To investigate the relationship between exercise and affect accurately it is important to first distinguish between the terms 'affect', 'emotion', and 'mood'. Ekkekakis et al., (2005a) defined 'affect' as the most basic or elementary characteristic component of all valenced (positive or negative, pleasant or unpleasant) responses, including, but not limited to, 'emotions' and 'moods'. In that sense, 'affect' is theorised to be a broader concept than 'emotions', which are distinct affective states and require cognitive appraisal of a stimulus. Likewise, 'moods' are also theorized to have a cognitive origin, but tend to be less intense and longer lasting than 'emotions', and are considered as lacking a specific target. 'Affect' may occur as a component of emotion or independent of any cognitive appraisal. For example, the feeling of pleasure associated with the satiation of hunger or thirst can be classed as affect and it does not require any cognitive appraisal. However, anger and embarrassment are distinct emotional states that include an underlying basic affective response (i.e., displeasure), as well as an appraisal process (Williams et al., in press). Ekkekakis and Petruzzello (2000; 2001a; 2001b; 2002) argued that many researchers in the past appeared to pay little attention to these distinctions when choosing or developing measures to assess 'affect' in an exercise context, which has likely contributed to a lack of conclusive research in this field. For a more detailed discussion of the differentiation of these terms and their importance in exercise psychology research, see Ekkekakis & Petruzzello (2000).

Theoretical Framework

In their review, Ekkekakis and Petruzzello (1999) acknowledged that a key feature of exercise-affect research is that it lacked a strong theoretical framework. In the past, researchers employed both dimensional and categorical models to measure affect.

From a categorical perspective, affective states are organized in distinct categories (e.g., anger, happiness). From a dimensional perspective, affective states are considered systematically inter-related and their relationships can be modelled by a set of dimensions (e.g., the bipolar pleasure/displeasure dimension; Ekkekakis & Petruzzello, 2000). The notion of 'exercise-specific' affect became popular in the last decade, which led to the development of various categorical tools to measure the concept (e.g., the Exercise-Induced Feeling Inventory; EFI, Gauvin & Rejeski, 1993; and the Subjective Exercise Experiences Scale; SEES, McAuley & Courneya, 1994). According to Ekkekakis and Petruzzello (2000, 2001a, 2001b, 2002), these measures were developed without reference to a theoretical understanding of the nature of affective responses to exercise, and they purport specific emotional states (e.g., 'revitalization' and 'tranquillity') for which conclusive evidence is lacking. Ekkekakis and Petruzzello (2002) declared that, "the strength of categorical models is their specificity and their ability to distinguish between affective states...they are deemed preferable to the study of distinct emotions". The strength of dimensional models is "their breadth of scope and parsimony. [They] can offer adequate representations of the entire affective space by relying on only a small number of basic dimensions (as few as two)" (p.36). In this respect, dimensional models are considered well suited for the study of basic affect from a global perspective.

Ekkekakis and Petruzzello (2002) proposed that, at the present stage of knowledge development, researchers should adopt a 'back to basics' approach, and that measurement in descriptive studies should focus primarily on basic affect. In light of this, given the sparse and inconclusive evidence of any specific emotional response to acute exercise, it is suggested that the analysis of affective responses to acute exercise employs a dimensional theoretical model as its conceptual framework:

"The breadth and parsimony of dimensional models make it feasible to detect salient affective changes in response to a variety of exercise stimuli without advance knowledge of the exact nature or direction of these changes." (p. 37, Ekkekakis and Petruzzello, 2002).

The Circumplex Model of Affect

In consideration of these observations, Ekkekakis and Petruzzello (2002) proposed Russell's (1980) circumplex model of affect as the theoretical basis for affective research in exercise contexts. They argued that this is the most reasonable option given the factors discussed, and expressed surprise that it has been "virtually ignored in exercise psychology" (p. 38) given its popularity in other areas of psychological investigation. The following description of the model has been adapted from Ekkekakis and Petruzzello (2002):

The model is characterized by two dimensions, namely affective valence (also termed *pleasure-displeasure* or *hedonic tone*) and perceived activation (also termed *arousal*). These dimensions are theorized to be bipolar and orthogonal, and different affective states are considered to be combinations of varying degrees of these two constituent dimensions such that affective states can be conceptualized as located around the perimeter of a circle defined by the two dimensions (see Figure 1.1). The circumplex can be divided into quadrants, producing four meaningful variants of affective experience:

1. High-activation pleasant affect, which corresponds to an excitement-like state;
2. High-activation unpleasant affect, corresponding to tension and distress;
3. Low-activation unpleasant affect, characteristic of boredom and depression;
4. Low-activation pleasant affect, a combination of calmness and relaxation.

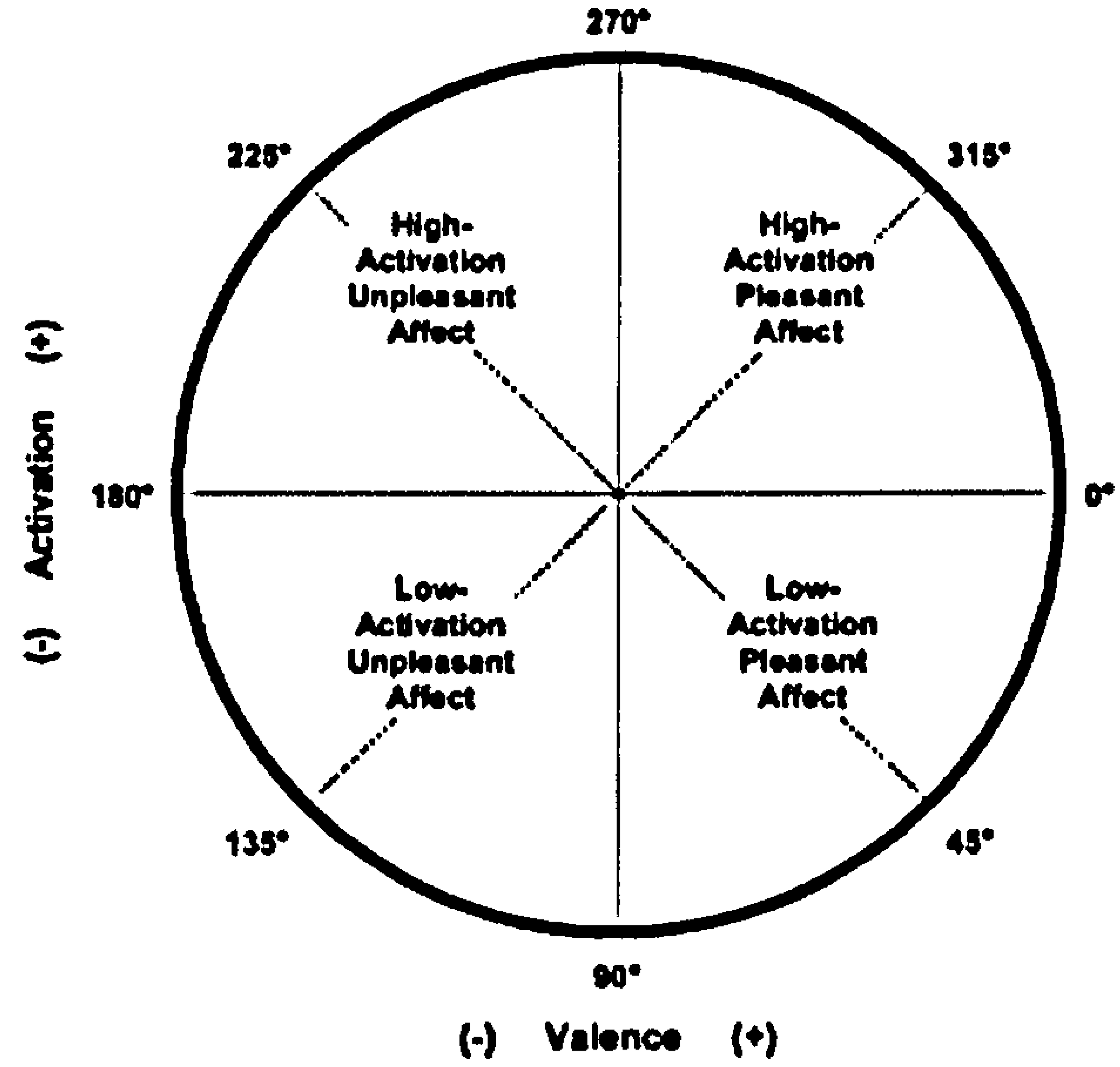

Figure 1.1. **The circumplex model of affect** (Russell, 1980; taken from Ekkekakis & Petruzzello, 2002). The horizontal axis represents affective valence (negative to positive) and the vertical axis represents the degree of perceived activation (low to high).

There has been substantial debate over the years about the true structure of affect and, in particular, whether there is a case for additional dimensions. This is based upon the observation that these two dimensions leave a percentage of the variance between affective states unaccounted for (Ekkekakis & Petruzzello, 2002). A number of additional broad factors have been proposed to account for this, including *potency* (also referred to as *dominance-submissiveness*; Osgood, 1969; Russell & Mehrabian, 1977), *aggressiveness* (Markus & Kitayama, 1991), and *locus of causation* (Russell, 1978). However, it has been argued that these constructs are more concerned with the event that elicits a reaction - parts of emotional episodes - and therefore outside the realm of core affect (Russell & Feldman Barrett, 1999). Thus, these additional dimensions are most likely to be antecedents or consequences of the affective experience (Russell, 1989). Ekkekakis and Petruzzello (2002) further reinforce the use of the circumplex model as a framework for measuring affect during exercise by highlighting that the purpose of dimensional models is to account for as much of the variability between affective states with as few dimensions as possible, and the additional complexity associated with the transition from a two-dimensional to a three-dimensional structure is considerable.

Another debate surrounds the issue of whether core affective states are independent or, as depicted by the circumples model of affect, bipolar opposites. Additional models have interpreted the dimensions as two dimensions of valence (positive and negative; Watson & Tellegen, 1985) and as two dimensions of activation (Thayer, 1989). However, Watson and Tellegen's two valence dimensions implicitly involve activation and Thayer's two activation dimensions implicitly involve valence. For example, Watson and Tellegen's (1985) independent dimensions that anchor the affective space, have been called Positive and Negative Affect (or PANAS [Positive Affect Negative Affect Schedule]-PA and PANAS-NA, respectively). So defined, PANAS-PA is the combination of pleasantness and high activation; PANAS-NA, the combination of unpleasantness and high activation. These affective states are about 90° apart in the structure of affect, resulting in a correlation between them of approximately zero. Defined in this way, Feldman Barrett and Russell (1999) argue, Positive Affect and Negative Affect are not semantic opposites, and one would not expect them to be bipolar opposites. Irrespective of the structure of the dimensions, however, Russell and Feldman Barrett (1999) emphasize that no matter how one parses affective space, it consists of combinations of valence and activation.

The Affect Circumplex as a Measurement Tool in Exercise Research

A number of single item measures have been developed on the basis of the circumplex model (e.g., the affect grid; Russell, Weiss, & Mendelsohn, 1989), but Ekkekakis and Petruzzello (2002) recommended the use of separate bipolar scales of affective valence, as measured by the Feeling Scale (FS; Hardy & Rejeski, 1989), and perceived activation, as measured by the Felt Arousal Scale (FAS) of the Telic State Measure (Svebak & Murgatroyd, 1985). Multi-item scales have also been suggested for the measurement of the dimensions of the circumplex model (e.g., the Activation Deactivation Adjective Checklist (AD ACL; Thayer, 1986; 1989), although these are not conducive to repeated measurements during an exercise bout. The most beneficial feature of the FS and FAS, however, is that they can be used repeatedly before, during and after exercise with only a small risk of respondent overload and inducing reactivity to testing (Ekkekakis & Petruzzello, 2002).

Arguments have been presented against the use of the circumplex model in an exercise context. In particular, Gauvin and Rejeski (2001), authors of the multi-item Exercise-Induced Feeling Inventory (EFI; Gauvin & Rejeski, 1993), argued that this two-dimensional representation of affect is oversimplified and that categorical models should not be discounted. However, Ekkekakis and Petruzzello (2004) maintained that the two approaches are compatible and not mutually exclusive; that they refer to different levels of a hierarchical structure of affect and correspond to different sets of phenomena. They stressed that the circumplex is *not* a model of *emotion* – it is a model that reflects a different level of the affective hierarchy, namely the level of *basic affect*. In contrast, the EFI measures distinct emotional states. Therefore, in agreement with Ekkekakis and Petruzzello (2002), the circumplex model of affect was employed as a framework for the measurement of affect in the present research as it was considered the most useful tool available for measuring affect repeatedly during exercise, given the current state of knowledge.

Timing of Affect Measurement

The majority of previous studies have measured affect and similar constructs pre- and post-exercise, neglecting measurement whilst the participant is exercising. *During-exercise* affect had largely been ignored in the literature until recently (Petruzzello, Jones & Tate, 1997; Ekkekakis & Petruzzello, 1999) even though it is arguably an imperative part of the 'exercise experience'. What exercise psychologists may have failed to appreciate to date is that any positive or less negative affective responses reported post-exercise may be in response to a very different experience during exercise, as suggested by Solomon's (1980) Opponent-Process theory and supported by Petruzzello et al. (1997) and Bixby, Spalding and Hatfield (2001). According to Solomon (1980, 1991) the rebound to positivity upon cessation of an exercise bout during which affect declines is the result of an affective opponent-process mechanism which functions to suppress or reduce all excursions from hedonic neutrality, and is brought into play whenever significant departures from affective equilibrium occur. This concept is consistent with Cabanac (1971), who suggested that pleasure occurs whenever a sensation indicates the presence of a stimulus which helps to correct an internal trouble (e.g., the inability to maintain a physiological steady state during high intensity exercise). Evidentially, the 'feel good' factor experienced after exercise may be the direct result of a 'feel bad' factor during exercise.

Activity Status and the Definition of Exercise Intensity

Those studies that have investigated affect during exercise have resulted in somewhat contradictory findings, particularly when individual activity status has been taken into account. For example, Daley and Welch (2003) found no difference between changes in the affective states of active and low-active females during and after 'high' as well as 'low' intensity exercise. In contrast, Parfitt, Markland and Holmes (1994) reported that highly active participants were significantly more positive than low-active individuals during 'high' intensity than during 'low' intensity exercise. Boutcher, McAuley and Courneya (1997), on the other hand, identified that trained individuals' responses to the PANAS (Positive And Negative Affect Schedule; Watson, Clark & Tellegen, 1988) resulted in more positive affect during both 'moderate' and 'hard' intensity, but not during 'low' intensity exercise, whereas untrained individuals showed decreased positive affect after exercise and decreased negative affect during and after exercise.

However, Boutcher et al. (1997) found no differences between groups in response to the Feeling Scale (FS; Hardy & Rejeski, 1989). In comparison, Reed, Berg, Latin and La Voie (1998) found that active participants' responses to the FS were significantly more positive throughout and five minutes after exercise at a 'moderate' intensity than sedentary participants. The difference between groups in this case was due to significant *increases* in positive affect that were seen for the active group during and after exercise, but did not occur in the sedentary group. Rudolph and McAuley (1998) also measured affective responses using the FS during and after running at a 'moderate' intensity. This study similarly showed that affect scores were higher for runners during and after exercise than for non-runners. However, this difference was due to the significant *decrease* in affect of the non-runners. Whilst one explanation for these apparent inconsistencies may be the variety of 'affect' measurement scales employed in these studies, another contributor could be that the range of methods used to measure exercise intensity may have caused interpretational errors.

Throughout the literature inconsistent and varied definitions of exercise intensity have been employed. For example, 50% of age-predicted maximal Heart Rate Reserve (HRR; e.g., Blanchard, Rodgers, Spence & Courneya, 2001), 50-55% of age-predicted maximum Heart Rate (HRmax; e.g., Daley & Welch, 2003), and a Rating of Perceived Exertion (RPE) of 9 (e.g., Parfitt, Eston, & Connolly, 1996) have all been used to define 'low' intensity. 'Moderate' intensity definitions have been as varied as 50-55% HRR (Treasure & Newbery, 1998), 50% $\dot{V}O_2\,max$ (e.g., Steptoe, Kearsely & Walters, 1993; Reed et al., 1998), 60% $\dot{V}O_2\,peak$ (e.g., Dunn & McAuley, 2000; Rudolph & McAuley, 1998; Parfitt et al., 1994), and RPE of 13 (e.g., Boutcher et al., 1997; Parfitt et al., 1996). Likewise, 70-75% HRR (e.g., Treasure & Newbery, 1998), 80% HRR (e.g., Blanchard et al., 2001), 80-85% HR max (e.g., Daley & Welch, 2003), 70% $\dot{V}O_2$ max (e.g., Steptoe et al., 1993), 80% $\dot{V}O_2$ peak (e.g., Dunn & McAuley, 2000), 90% $\dot{V}O_2$ max (e.g., Parfitt et al., 1994), RPE's of 16 (e.g., Boutcher et al., 1997) and 17 (e.g., Parfitt et al., 1996), have all been defined as 'high' or 'vigorous' intensity.

It seems that although tentative steps have been made towards a greater understanding of the relationship between exercise intensity and psychological affect, we now have a wealth of literature that tells us little about any dose-response patterns and has left only considerable gaps and even more questions. Any attempt to draw conclusions about the effect of exercise intensity on psychological factors has been made particularly difficult as the definition of intensity has not been standardised across the field. In addition, it appears that conflicting results are accentuated when activity status and/or fitness level of participants are taken into account. Clearly, the definition of exercise intensity is an important issue that needs consideration in this dose-response debate, as are individual differences in aerobic fitness.

A New Era of Exercise-Affect Research

It has recently been argued that exercise psychologists may well have overlooked any variance in data collected, or dismissed it as 'noise', because of the penchant to limit enquiries to testing averages (Van Landuyt, Ekkekakis, Hall & Petruzzello, 2000). This was demonstrated by Van Landuyt et al. (2000; see Figure 1.2) who's study drew attention to the importance of close investigation of data prior to statistical analysis. Participants exercised at 60% $\dot{V}O_2$ max for 30 minutes, and affective responses were recorded using the FS and FAS at 5-minute intervals throughout exercise, as well as before and after exercise. They found that, although 97% of the participants reported either an increase or no change in activation during exercise, 44% reported a progressive improvement in valence, whereas 41% reported a progressive decline. As a result of these divergent trends, the *average* valence responses appeared unchanged during exercise, yet in truth they varied considerably between individuals.

This interindividual variation during exercise at an intensity that has traditionally been categorised as 'moderate' (i.e., 60% $\dot{V}O_2$max) reveals a pressing need to better understand the mechanisms underpinning affective responses to exercise. It has been suggested that this method of defining intensity could be the cause of intra-group variability in exercise-affect research, as a fixed percentage of aerobic capacity could be marked by different mixtures of aerobic and anaerobic processes for different individuals (Bixby et al., 2001; Van Landuyt et al., 2000). The importance of this concept is discussed in detail later (see p. 28).

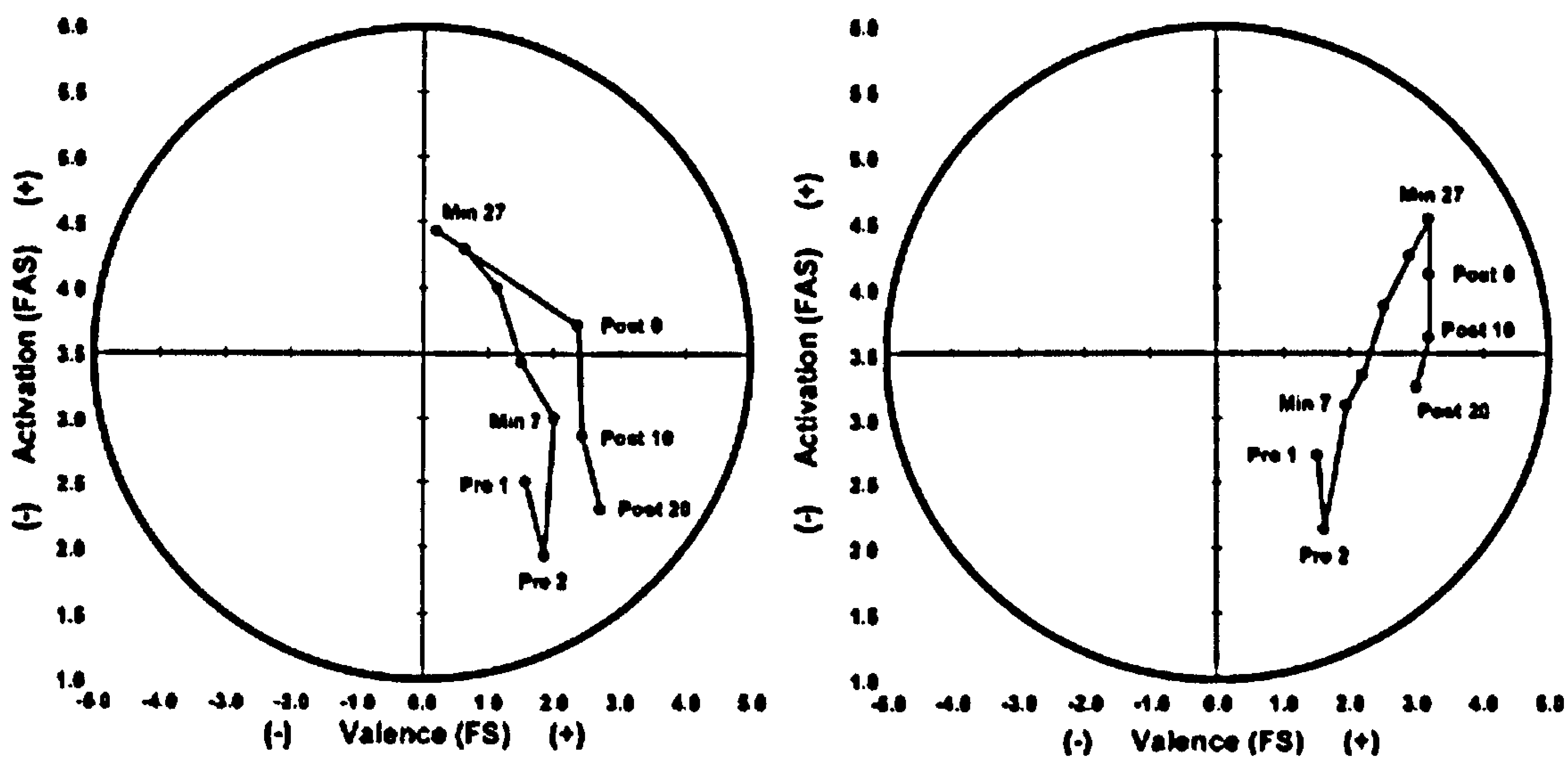

Figure 1.2. **Responses to a 27-min bout of cycle ergometry at 60% of estimated maximal aerobic capacity and 20-min recovery.** The sample is divided into participants who reported progressive improvement (right panel) and progressive deterioration (left panel) in affective valence during exercise. (Reproduced from Van Landuyt et al., 2000, with permission.)

Hall, Ekkekakis and Petruzzello (2002) took the first steps towards investigating this notion by examining the minute-by-minute ratings of valence and activation as exercise intensity (the speed and incline of a treadmill) was gradually increased until each participant reached the point of volitional exhaustion. The results showed that, during the early stages, affective response was characterized primarily by an increase in activation, with little change in valence. After the transition to anaerobic metabolism (i.e., the ventilatory threshold; VT[2]), however, the increase in activation was coupled with a substantial shift towards negative valence (see Figure 1.3).

Another study (Ekkekakis, Hall & Petruzzello, 2007), in which 30 healthy, active participants ran at a constant pace for 15 minutes at three intensities (one below[<] VT, one at[@] VT and one above[>] VT), yielded similar results; with increasing intensity there were larger increases in activation and declines in valence. Arguably the most interesting observation in these studies is that examination of minute-to-minute changes in valence showed large variability <VT; 2 individuals (7%) showed an increase in valence ratings, 15 individuals (50%) showed no change, and 13 individuals (43%) showed a decrease. However, in the @VT and >VT conditions, a relatively homogeneous shift towards negative valence was demonstrated. Specifically, in the @VT condition, 4 individuals (13.3%) showed an increase in FS ratings, 3 individuals (10%) showed no change, and 23 individuals (77%) showed a decrease. In the >VT condition, only 3 individuals (10%) showed an increase, 3 individuals (10%) showed no change, and 24 individuals (80%) showed a decrease in affective valence. Furthermore, all results were characterised by a homogeneous positive shift in affective valence immediately following exercise.

Bixby et al. (2001) similarly fixed exercise intensity as relative to healthy, active participants' VT in measurement of affective responses to 30 minutes of exercise at different intensities (low intensity = 75% of VT; higher intensity = at ~VT). Although they used different measures of affect to Ekkekakis et al. (2007), Bixby et al. (2001) also found that low intensity exercise led to a mean improvement in affective states

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[2] The terms 'ventilatory threshold', 'lactate threshold', and 'anaerobic threshold' have all been used throughout the literature to label what is essentially the same metabolic landmark. For the purpose of this thesis, the term 'ventilatory threshold' will be used, unless discussing or comparing studies that have used different terms. However, it is important to note that the author is not making any comment on what the most appropriate physiological term is for this metabolic marker.

during exercise, and that the higher intensity exercise bout led to a decline, though both intensities resulted in improved affect post-exercise.

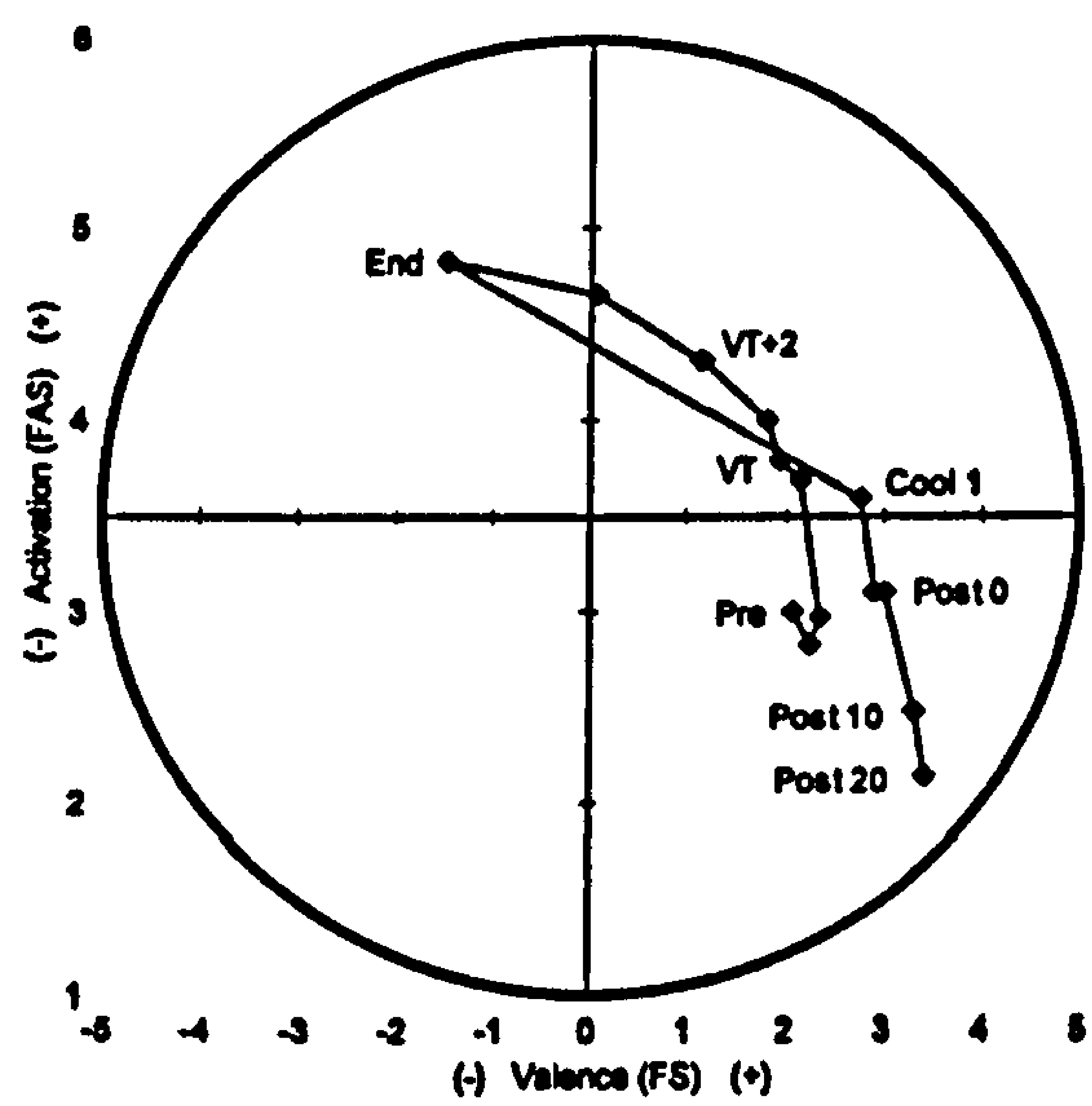


Figure 1.3. **Affective responses to a graded treadmill test performed until volitional exhaustion and a 20-minute recovery period.** (Note: VT = Ventilatory Threshold; VT+2 = min 2 after the VT; Cool 1 = min 1 of the cool-down). (Data from Hall et al., 2002, with permission.)

Recently, Parfitt, Rose and Burgess (2006) measured sedentary male participants' affective responses during exercise at different intensities using the anaerobic threshold as a demarcation of intensity. The 12 participants completed 3 exercise conditions: one below the lactate threshold (LT), one above, and one at a self-selected intensity. Interestingly, participants' self-selected intensity appeared to approximate the LT. Findings differed somewhat to Ekkekakis et al. (2007) and Bixby et al. (2001), in that the majority of participants' affective valence responses increased below the LT, although there was also a great deal of interindividual variability in this condition. There was much less variability in the other two conditions, with 92% of participants' valence responses *increasing* in the self-selected condition, and 83% *decreasing* in the above-lactate condition. It is interesting to note that Parfitt et al. (2006) observed the most positive responses in an intensity condition that corresponded with the aerobic-anaerobic transition point (i.e., LT), yet Ekkekakis et al. (2007) reported that the majority of participants' valence responses declined at a similar intensity. The fact that Parfitt et al.'s (2006) participants *chose* this intensity themselves, rather than had it imposed, is a likely explanation of this discrepancy. This concept will be discussed further in reference to the theoretical mechanisms underlying affective responses at this intensity (see p. 28-29).

At this point it is important to reiterate the value of measuring affect during exercise. If this temporal assessment consideration had not been employed in these studies (i.e., Bixby et al., 2001; Hall et al., 2002; Parfitt et al., 2006; Ekkekakis et al., 2007), as is often the case in the exercise psychology literature, it would likely have been concluded that low, moderate and high intensity exercise provide equivalent improvement in affective states. Instead, as a result of these recent findings researchers have suggested that there are different mechanisms at different exercise intensities that govern the affective state experienced (Bixby et al., 2001; Ekkekakis 2003). These observations led Ekkekakis (2003) to propose a 'dual-mode model' to explain the intensity-affect relationship.

Mechanisms of Exercise-Induced Affect

Many different psychological and physiological mechanisms (e.g., the mastery hypothesis, distraction theory, changes in brain neurotransmitters and the release of endorphins) have been proposed to account for underlying improvements in affect that are observed upon exercise cessation (for representative reviews see Tuson & Sinyor, 1993; Morgan, 1997). However, these theories broadly fail to address changes in affect that occur whilst one is exercising. Some theoretical explanation of affective experiences *during* exercise can be found in the parallel processing model (Leventhal, 1979; Leventhal & Everhart, 1979). Originally developed to provide explanation for the processing of pain stimuli, this model views the informational (i.e. stimulus attributes) and emotional (i.e. generation of perception) qualities of pain as being processed simultaneously. Thus, an individual does not need to conscientiously experience pain before an emotional response is evoked.

This model also distinguishes between *perception* (what *can* be attended to) and *focal awareness* (what *is* being attended to). According to this model, most of the processing of sensation and emotion occurs preconsciously, and a major role in determining what is brought into focal awareness is played by attention. The later inclusion of attentional channels (or filters) in this model, which is similar to the notion of associating or dissociating during physical activity, demonstrates the specific relationship between perception and focal awareness. If the channels are open (i.e. associating), the information of what *can* be attended to is transmitted to focal awareness and becomes information of what *is* attended to. Conversely, if the channels are closed (i.e. dissociating), information is still being processed on a preconscious level, but not at an intensity to gain focal awareness. The parallel processing model significantly advanced the understanding of the mechanisms underlying emotions. However, deficiencies in it's applicability to exercise stimuli have since been highlighted.

Rejeski (1985) altered the parallel processing model to explain the mechanisms underlying perceptions of exertion during exercise. Specifically, it was argued that perception is not a passive process, as assumed in the original model, but rather an active process that is amenable to cognitive and affective factors. Furthermore, the point was made that the original model failed to account for "*how environmental and task variables contribute to the perceptual salience of specific physiological variables during exercise*" (p. 376). Rejeski argued that as exercise intensity increases physiological cues override cognitive appraisal of exertion. It is important to note that Rejeski's (1985) model served to provide explanation for *what* one feels during exercise (i.e., perceptions of exertion), but does not address the reasons underlying *how* one feels (i.e., the affective component). Additionally, the theory fails to consider 'the' intensity at which physiological variables begin to dominate perception, or whether there is any interindividual variability. Thus, while the original parallel processing model and Rejeski's (1985) modifications were important theoretical advancements for the field of exercise psychology, a sound explanation for affective changes that occur during exercise of varying intensities has, until recently, remained lacking.

The Dual-Model Model

Based on a small number of preliminary studies and information from neuroscience, Ekkekakis (2003) proposed the dual-mode model as a theoretical depiction of the relationship between exercise intensity and affective responses, so named because of the conceptualised dual influences on affective responses to exercise. Specifically, Ekkekakis (2003) postulated that affective responses during exercise are the products of the continuous interplay between two general factors, both of which have access to the affective centres of the brain. These 'dual' mechanisms comprise, (a) relevant cognitive processes originating primarily in the pre-frontal cortex (involving such processes as appraisals of the meaning of exercise, goals, self-perceptions including self-efficacy, attributions, and considerations of the social context of exercise) and, (b) interoceptive cues (i.e., sensations associated with the physiological condition of the body; Craig, 2002) from a variety of receptors stimulated by exercise-induced physiological changes. Although he asserts that these are two distinct processes, Ekkekakis (2003) maintains that neither mode is likely to have complete control over affective responses to exercise. Instead, the relative dominance and respective influence of these two mechanisms, and the way affective responses are manifested, vary across 3 distinct 'domains' of exercise intensity (Ekkekakis, 2003; Ekkekakis et al., 2005a); the basic tenets of which are outlined below:

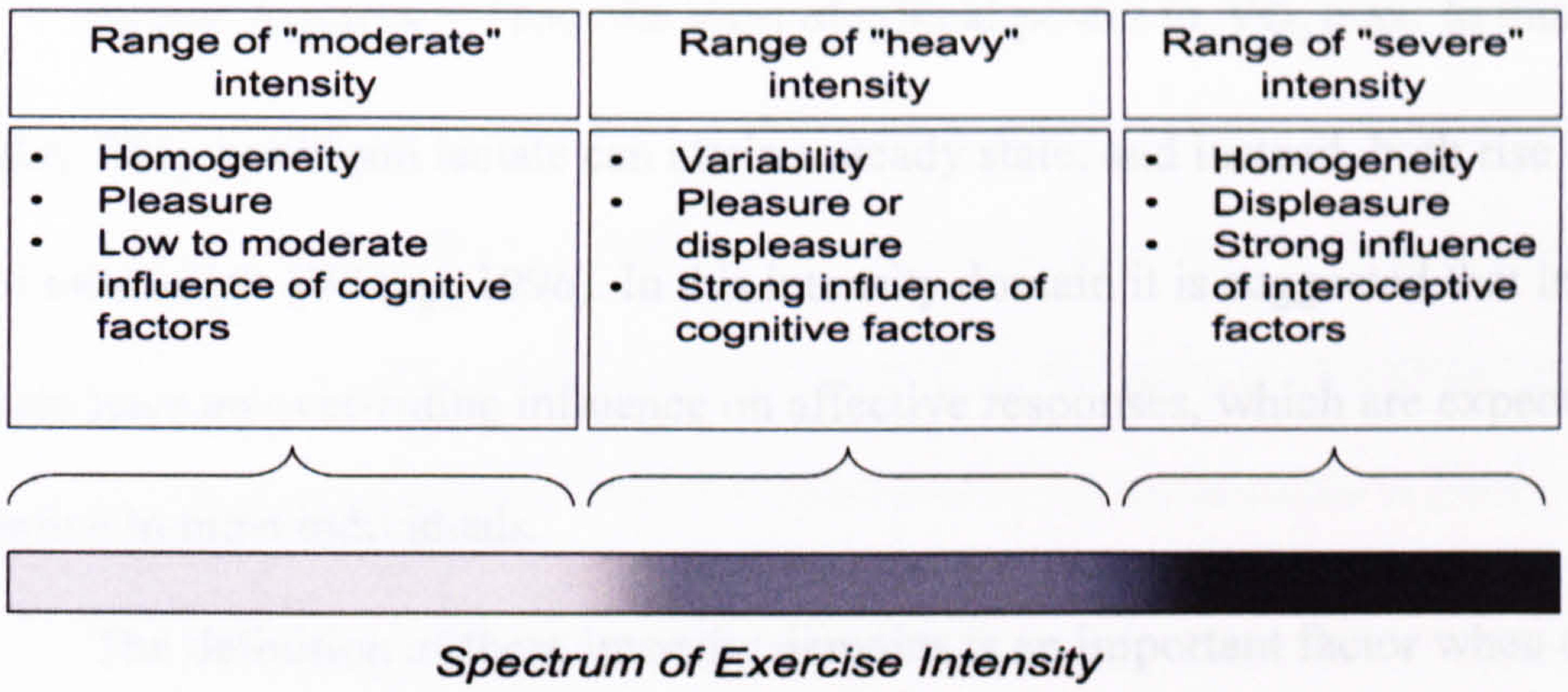


Figure 1.4. **The Dual-Mode Model.** (Reproduced from Ekkekakis et al., 2005a, with permission.)

Moderate Intensity = Below the VT, where there is no sustained increase in $\dot{V}CO_2$ [rate of carbon dioxide output] in proportion to the increase in $\dot{V}O_2$, no increase in blood lactate, or decrease in arterial blood pH (e.g., Whipp & Özyener, 1998). Within this range, one can exercise for prolonged periods of time, as blood lactate concentration and oxygen uptake remain in a steady state and the capacity for sustained aerobic energy repletion is not exceeded. In this domain affective responses are expected to be primarily positive, with relatively low interindividual variability, and with cognitive factors having a low to moderate influence on affective responses.

Heavy Intensity = From the ventilatory threshold to the level of critical power (the highest work rate at which blood lactate and $\dot{V}O_2$ can be maintained in a steady state; Poole, Ward, Gardner, & Whipp, 1988). In this domain, despite elevated blood lactate levels, exercise can be sustained for relatively prolonged periods, but with higher associated physiological stress than for moderate exercise (i.e., below VT). Affective responses are expected to exhibit marked interindividual variability, such that some individuals may report changes towards pleasure, whereas others may report changes towards displeasure. It is hypothesised that cognitive factors will have a strong influence on affect in this domain.

Severe Intensity = From the level of critical power to $\dot{V}O_2$ max. In this range, neither $\dot{V}O_2$ nor blood lactate can attain a steady state, and instead, both rise inexorably until exhaustion (Whipp, 1996). In this intensity domain it is suggested that interoceptive factors have an over-riding influence on affective responses, which are expected to be negative in most individuals.

The definition of these intensity domains is an important factor when one considers how intensity has typically been defined in past exercise psychology research. In fact, distribution of the normal range of VT extends from 35-80% of $\dot{V}O_2$ max (Whipp, 2004), and it has also been demonstrated that the onset of critical power can vary widely between 25 and 95% of the range from VT to $\dot{V}O_2$ max (Neder, Jones, Nery & Whipp, 2000). These interindividual differences are based upon a combination of factors, including age, weight, gender, cardiovascular fitness, and genetics. Metabolic landmarks, such as the VT, have a profound adaptational significance, as the metabolic profile changes dramatically when exercise is performed slightly below or slightly above them. One participant exercising at 60% of $\dot{V}O_2$ max (e.g., in Van Landuyt et al., 2000) may be working above their VT, whereas another may be working at or below it. Understandably, therefore, the "common practice of reporting exercise intensity as a percentage of $\dot{V}O_2$ max [at heavy and severe intensities]" has been labelled as "fundamentally flawed" (Gaesser & Poole, 1996; p. 43).

The dual-mode model represents a crucial development as it could serve to explain the variability in results that pervade the exercise psychology literature. In addition, this theory provides a mechanistic explanation for the observation that participants responded positively during exercise that approximated the anaerobic threshold and was self-selected in Parfitt et al.'s (2006) study, but negatively to a similar intensity in Ekkekakis et al.'s (2007) study. According to the theory, cognitive appraisal factors govern affective responses at this intensity, so allowing participants to choose their intensity may have influenced their self-efficacy positively via increasing perceptions of control, and may have also increased self-determination and competence-motivation levels (Parfitt et al., 2006). In contrast, having the intensity imposed in Ekkekakis et al.'s (2007) study may have caused participants to experience more negative cognitive appraisal of the task than that experienced by participants in Parfitt et al.'s (2006) study.

The Influence of Cognitive Appraisal upon Affective Responses

From a theoretical perspective, the concept that cognitive appraisal factors may govern affective responses to exercise at and below VT of particular interest considering that there is evidence for a great deal of interindividuality in affective responses at these intensities (e.g., Ekkekakis et al., 2007; Parfitt et al., 2006; Ekkekakis et al., 2005a). This is also important from a practical perspective considering the evidence that inactive individuals appear to self-select an exercise intensity that corresponds with the anaerobic threshold (Parfitt et al., 2006; Lind, Joens-Matre & Ekkekakis, 2005). The obvious next challenge to researchers, therefore, is to test this notion and identify specific source(s) of this variability.

The importance of cognitive appraisal of a given task was central to Bandura's (1986) Social Cognitive Theory, which also suggested that self-efficacy expectations influence affect. Indeed, self-efficacy is one variable that has been studied extensively in the context of exercise behaviour and exercise/affect research (e.g., McAuley, Talbot & Martinez, 1999; Treasure & Newbury, 1998; McAuley, Blissmer, Katula, Duncan, & Mihalko, 2000; Bray, Gyurcsik, Culos-Reed, Dawson & Martin, 2001). Likewise, the role of attentional focus (i.e., associative vs. dissociative thought patterns) on affective responses to exercise has also received some recent research attention (e.g., Blanchard, Rodgers & Gauvin, 2004; La Caille, Masters & Heath, 2004). Both attentional focus and self-efficacy are specific variables that deserve further consideration as mediators of affective responses during exercise as there is evidence that they are both transient and can be manipulated (e.g., McAuley et al., 1999; Masters & Ogles, 1998). This is also an important consideration from an applied perspective as it implies that strategies could be used to enhance these cognitions, which could have an impact upon the affective experience of exercise.

The Role of Self-Efficacy

According to Bandura (1997), perceived self-efficacy refers to "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). People's beliefs in their efficacy have diverse effects. Bandura argues that motivation, affective states and actions are based more on what people believe than what is objectively true. Efficacy cognitions are, thus, theorised to be important determinants of behaviour, thought patterns and affective reactions in situations perceived as challenging. To date, there has been considerable interest in the relationship between task self-efficacy and exercise-induced affect. A specific question that has received particular attention is whether the variance in affective responses can be accounted for by self-efficacy changes as a function of exercise intensity. It has been suggested that self-efficacy becomes a salient mediator of affect when the intensity of exercise presents an appreciable challenge (e.g., 70% of maximal heart rate; McAuley & Courneya, 1992), but, if the intensity is too high, its influence is weakened because "physiological cues...override cognitive processing" (McAuley, Blissmer, Katula & Duncan, 2000, p. 352). This notion is somewhat consistent with the tenets of the dual-mode model, yet the data on this issue are inconsistent.

McAuley and Courneya (1992) investigated feeling scale responses to a graded exercise test (GXT) in 88 sedentary middle-aged participants. Pre-exercise self-efficacy explained 3% of variance in affect at the end of the GXT (at 70% HRmax). The authors concluded that a stronger efficacy-affect relationship should exist with exercise intensities above 70% HRmax. However, Tate, Petruzzello and Lox (1995) tested this hypothesis and found evidence to suggest that the efficacy-affect relationship during exercise weakened as intensity increased. In this study, pre-exercise efficacy significantly predicted approximately 6% of the unique variation in negative affect reported halfway through a 30 min exercise bout at 55% $\dot{V}O_2$ max, but not at 70% $\dot{V}O_2$ max, in a highly active sample.

The notion that high self-efficacy is related to more positive/less negative during-exercise affect also finds support from investigations that have manipulated self-efficacy perceptions. By providing participants with false feedback after an aerobic fitness test, both McAuley et al., (1999) and Jerome, Marquez, McAuley, Canaklisova, Snook & Vickers (2002) manipulated the pre-exercise self-efficacy perceptions of low-moderately active women before they engaged in 20 min of 'moderate' intensity exercise (RPE = 12-16). McAuley et al. (1999) reported significant correlations between self-efficacy and positive well-being (measured by the subjective exercise experiences scale; McAuley & Courneya, 1994) during and immediately post-exercise in the high-efficacy condition, but not in low-efficacy condition. In explanation, McAuley et al. (1999) suggested that when perceived efficacy is low, attentional focus is on physiological cues and such attention overrides the efficacy-affect relationship. However, Jerome et al. (2002) reported that pre-exercise self-efficacy and feeling states during exercise were unrelated, thereby failing to provide endorsement for McAuley et al.'s (1999) consensus. Another explanation for the contradictory results, based upon dual-mode theorising, could be that participants in the two different studies were experiencing distinctly different metabolic work loads, especially considering the wide range on the RPE scale that was used as a 'control' of exercise intensity. Participants' perceptions of exertion in both studies ranged from 12-16 on Borg's (1998) RPE scale, which means that they were exercising anywhere between 'fairly light' and 'somewhat hard' (RPE = 12) to somewhere between 'hard' and 'very hard' (RPE = 16).

This deduction also finds support in another study that seems to provide support for the influence of self-efficacy upon during-exercise affective responses. Bozoian, Rejeski and McAuley (1994) did not manipulate self-efficacy but divided 36 active females into two groups depending upon whether their pre-existing self-efficacy perceptions were above or below the group median. More efficacious females reported having more positive feeling states than their low efficacious counterparts throughout and after a 20 min exercise bout at 70%HRR. In addition, low efficacy individuals experienced a significant reduction in revitilization during exercise before returning to baseline levels post-exercise, suggesting deteriorated affective states during exercise for low-efficacy women. However, conclusions are complicated by the method used to control exercise intensity, as at 70% HRR low-efficacy participants may have been working at a distinctly different metabolic intensity in comparison to their high efficacy counterparts. According to the dual-mode model, this could have a direct impact upon the strength of the efficacy-affect relationship. Thus, until metabolic indices of exercise intensity are controlled for, it will be difficult to ascertain the importance of self-efficacy upon affective responses.

To examine the relationship between self-efficacy and affective valence across a greater range of intensities, and in the only study that took into account the balance between aerobic and anaerobic metabolism, Ekkekakis, Hall and Petruzzello (1999) used an exercise protocol in which the speed and grade of the treadmill were increased every minute, from a slow jog to the point of volitional exhaustion. The relationship between self-efficacy and valence was shown to be weak below the aerobic-anaerobic transition and at the point of exhaustion, but stronger around the point of transition, when, as suggested by Ekkekakis et al. (1999), the challenge to participants was presumably considerable but not overwhelming. This study appears to provide solid support for the notion that cognitive appraisal factors, such as self-efficacy, govern affective responses around the VT, which could explain the variance in affective responses at this intensity (Ekkekakis, 2003; Ekkekakis et al., 2005a)

Though the relationship between self-efficacy and affect across exercise intensities illustrated by Ekkekakis et al. (1999) seems at first glance to be fairly conclusive, there are two seemingly obvious questions that have still not been addressed: do self-efficacy perceptions change during an exercise bout, and are during-exercise self-efficacy perceptions related to during-exercise affective responses? Only one published study to date has studied the relationship between self-efficacy responses during exercise and affect. Treasure and Newbery (1998) investigated the relationship between self-efficacy (measured 5 minutes into a 15-minute exercise bout), exercise-induced feeling states (measured at 14.5 minutes) and exercise intensity. Sedentary individuals (n=60; 42 females, 18 males) were divided into 3 condition groups: exercise at 70-75% HRR, exercise at 45-50% HRR and a no-exercise control. Hierarchical regression analyses showed that self-efficacy at 5 min did not predict affect at 15 min in the low intensity condition, but it did explain 15% of the variance in 'physical exhaustion' at min 15 in the 'high' intensity condition. Unfortunately, this study utilised a between-subjects design and self-efficacy measures differed depending upon which condition individuals were assigned to, which means that between-condition comparisons are inconclusive.

The traditional method of measuring self-efficacy beliefs only before and, sometimes, after exercise may provide only a limited view of the impact of self-efficacy upon affect. According to self-efficacy theory (Bandura, 1997), enactive mastery experiences are the most influential source of efficacy information because they provide the most authentic evidence of whether one can muster what it takes to succeed.

However, Bandura also stipulates that the extent to which people alter their efficacy through performance experiences depends not only upon preconception of capability, but also upon perceived task difficulty and effort, which may alter as an exercise bout progresses. In addition, substantial physiological changes occur upon the instigation of and throughout exercise, which are also theorised to directly influence self-efficacy perceptions (Bandura, 1997). Based upon these suppositions, it can be suggested that self-efficacy, like affect, may vary over the course of an exercise bout, and that pre-exercise efficacy perceptions may vary considerably in comparison to during-exercise perceptions. To date, this concept has not been investigated, yet the true relationship between affect and self-efficacy during exercise can not arguably be identified until both are monitored throughout exercise. In light of this observation, and a recent call for further investigation of the relationship between self-efficacy and exercise-induced affect (e.g., Gauvin & Rejeski, 2001), it is proposed that perceptions of self-efficacy should also be measured throughout the exercise bout in order to conduct a thorough exploration of the exercise experience. This is deemed especially important when the population of interest are relatively low-active and may therefore have limited recent experience of exercise to draw upon when estimating self-efficacy before exercise.

The Role of Attentional Focus

Goode and Roth (1993) suggested that the cognitions of the exerciser (i.e., what one thinks about while exercising) may be one potential contributor to exercise-induced feeling state changes. They showed that dissociative thought during running (e.g., thinking about daily events) was significantly related to increases in vigour and decreases in tension from pre- to post-exercise, whereas associative thought during running (e.g., listening to breathing) was related to increases in fatigue. Their study was the first to show a relationship between attentional cognitions during running and mood, but it was limited in that the assessment of thought content was done retrospectively (i.e., thoughts during running were obtained post-exercise via a questionnaire; Blanchard et al., 2004). Like many of the early studies into exercise-induced feeling states, their study measured mood responses (not affect) only before and after exercise, so the results were not indicative of any relationship during exercise.

La Caille et al. (2004) manipulated attentional focus strategies during running by having participants engage in two between-group conditions; one where participants were asked to focus upon continual heart rate data feedback (association), and the other where they focused upon music (dissociation). Results indicated that participants in the music condition reported higher levels of tranquility post-exercise. Whilst these results add some understanding of the relationship between attentional focus and affect, there were a number of limitations of the study. For example, 'affect' (measured using the EFI; Gauvin & Rejeski, 1993) was only investigated post-exercise, not during exercise, and the intensity of exercise was not controlled for. Therefore, conclusions about the mechanisms underlying affective responses with respect to the dual-mode model are impossible.

Blanchard et al. (2004) addressed some of these issues when they studied exercise-induced feeling states in relation to cognitions during running. Participants completed two running conditions (25 and 40 min durations) at 70% HRR, during which they reported their thoughts into a microphone that was connected to a tape recorder. They found that participants reporting dissociative-external (as opposed to dissociative-internal, associative-external and associative-internal) thoughts experienced increases in revitalization from pre- to-post-exercise. These results offer additional support for the notion that dissociative strategies can improve affective states, but again, these affective states were measured only pre- to post-exercise. Also, the method used to classify exercise intensity gave no indication as to the intensity participants were working at relative to metabolic demands. Making conclusions is therefore problematic as, according to tenets of the dual-mode model (Ekkekakis, 2003; Ekkekakis & Petruzzello, 2005a), participants may have reported more associative thoughts if they were working above the ventilatory threshold compared to those working below the ventilatory threshold.

The Need for Further Research

Ekkekakis (2003) stipulated that, "the dual-mode model is primarily intended to stimulate new research into the relationship between exercise and affect" (p. 231). The need for further investigation is apparent when one considers that empirical evidence for the dual-mode model to date is based largely on evidence from a small number of studies (Ekkekakis, 2003). In particular, Hall et al.'s (2002) findings played a substantive role in the formulation of the dual-mode model. Data indicated that during exercise activation increased steadily throughout a maximal incremental exercise test to exhaustion, but affective valence remained positive until after the ventilatory threshold, when a significant shift towards displeasure occurred. The decline in valence then continued until exhaustion. All participants in this study were regularly active, healthy university students and were therefore not characteristic of the majority of the population. Given the current high levels of habitual inactivity, particularly amongst women (e.g., Sport England, 2006), and evidence that affective responses experienced during exercise may influence future behaviour (Williams et al., in press), a greater understanding of the mechanisms underlying the affective responses of low-active women during exercise is paramount.

Parfitt et al.'s (2006) investigation indicated that sedentary participants' (males, in this case) affective valence responses were variable, yet largely positive (58% of participants' valence levels increased) during relatively low-intensity exercise (i.e., below the lactate threshold; LT). In contrast, valence responses were largely negative during exercise above LT. Although these results indicate support for the dual-mode model within a sedentary sample, the intensity conditions were based upon the assumption that lactate levels of 2 mmol/l and 4 mmol/l were indicative of 'below-LT' and 'above-LT', respectively, in all participants. Therefore, these findings can not be deemed conclusive because absolute lactate levels at the lactate threshold may have varied from one person to the next (in the same way that the percentage of $\dot{V}O_2$ max at which VT is reached varies from one person to the next; Whipp, 2004). Further investigation of the tenets of the dual-mode model across exercise intensities is clearly necessary with a low-active sample, using direct measurement of the VT to accurately distinguish exercise intensity domains.

Of particular interest is the notion that interindividual variability of affective responses is a characteristic during exercise at and below the VT. Ekkekakis and Petruzzello (1999) recommended that, "Future research should...strive to dissect this variability by systematically studying the role of theoretically relevant mediators" (p. 339). The next logical step is to investigate individual differences thoroughly and assess whether these differences are governed by cognitive appraisal factors amongst low-active women. Of particular importance for investigation is the notion posited above that self-efficacy and attentional focus, measured throughout exercise, could be significant mediators of affective change patterns throughout exercise. In order to explore this thoroughly, the research presented in this thesis is unique in that it measures affect, self-efficacy and attentional focus repeatedly throughout exercise.

Summary and Research Objectives

This thesis is presented from the perspective of hedonic theory; i.e., the notion that we respond to situations we find ourselves in a positive or negative way in order to give guidance to future behaviour (Kahneman, 1999). Therefore, the level of affect experienced during exercise could be a good indicator of whether an individual will adopt or maintain a physically active lifestyle, a concept that preliminary evidence appears to uphold (Williams et al., in press). This is an important premise with respect to understanding female exercise participation as it has been estimated that only 18-25% of women meet weekly physical activity recommendations (JHS, 1998; Sport England, 2006). Research into the relationship between acute exercise and affect has produced largely contradictory findings, especially when variants in exercise intensity and activity status are taken into consideration. Recently, however, the dual-mode model (Ekkekakis, 2003; Ekkekakis et al., 2005a) was proposed to explain the relationship between exercise intensity and affect during exercise, and the mechanisms underlying this relationship. This model represents an important advancement in the field of exercise psychology, yet its principles are based mainly upon empirical research with active, healthy participants.

The model needs to be tested with a low-active female sample if it is to be used to further understanding of exercise-induced affective responses of women who have recently engaged in exercise programmes. More specifically, considering that guidelines for obtaining the health benefits of physical activity currently recommend a 'moderate' intensity (DCSM, 2002), the hypothesised role of cognitive appraisal factors (such as self-efficacy and attentional focus) in governing affect around the ventilatory threshold (Ekkekakis, 2003) deserves particular attention. In addition, interindividual variability of affective responses across exercise intensities necessitates detailed investigation as previous research has largely neglected this variability (Ekkekakis & Petruzzello, 1999; Ekkekakis et al., 2005a). Therefore, a series of studies will be presented that directly investigated the tenets of the dual-mode model within a low-active female sample; specifically the notions of interindividual variability and the influence of cognitive appraisal upon affective responses during exercise.

Chapter Two: Study One

A pilot investigation into variability of during-exercise affect and the role of activity status.

Introduction

Research into the relationship between exercise intensity and exercise-induced affect has been somewhat inconsistent in its findings (Ekkekakis & Petruzzello, 1999), a concept that is explored in detail in the introductory chapter of this thesis. Some of these contradictions may be explained by the range of methods used to measure "affect". However, even studies that have employed a simple, well-validated measure of core affective valence, namely the Feeling Scale (FS; Hardy & Rejeski, 1989), have yielded little indication of a dose-response relationship when activity status is taken into account. For example, Reed et al. (1998) examined the affective responses of 41 active and sedentary participants during and after exercise on a cycle ergometer at 50% $\dot{V}O_2$ max. FS scores were taken every 3 minutes during the 24-minute exercise bout and at 5 and 20 minutes post-exercise. Active participants were found to be significantly more positive during and 5 minutes after exercise than the sedentary participants, although sedentary participants exhibited elevated affect 20 minutes after exercise, indicating a delayed improvement in affect in the sedentary group. This effect was characterised by significant increases in affect were seen for the active group during and after exercise compared to the control group, but not for the sedentary group.

Rudolph and McAuley (1998) similarly measured affective valence using the FS during and after 30 minutes treadmill running at 60% $\dot{V}O_2$ max. This study also indicated that valence scores were higher for the active group (i.e., 'runners') during and after exercise than for the low-active group (i.e., 'non-runners'). However, this difference was due to the significant decrease in affect of the non-runners. Rudolph and McAuley (1998) also recorded higher RPE scores for the non-runners than the runners at this intensity.

Parfitt et al. (1994) studied FS responses to cycling in high- and low-active groups at both 60% and 90% $\dot{V}O_2$ max. They found that high-active participants showed more positive affective responses than low-active participants did at the higher intensity, but no significant difference was seen at 60% $\dot{V}O_2$ max. These results are, however, shadowed by questionable methodological factors in the aforementioned study (i.e., Parfitt et al, 1994). FS scores were reported as absolute, not comparative to pre-exercise baseline measures. Therefore affect can not truly be said to have increased or decreased, an important factor when discussing affective *responses* to exercise. In addition, participants were only instructed to exercise for 4 min, which presents concern for the ecological validity of the study as few people are likely to exercise in 4 min bouts in reality.

When examined within the context of the dual-mode model, it is arguable that the variation in results between these studies could be the result of the active participants working at different metabolic exercise intensities relative to their inactive counterparts, or due to differences in the relative influence of cognitive appraisal factors (depending upon the proximity of 50% and 60% $\dot{V}O_2$ max to the VT for each individual). Indeed, it is particularly difficult to accept 'no significant difference' conclusions that were made at 60% $\dot{V}O_2$ max given the results of Van Landuyt et al. (2000). Participants in Van Landuyt et al.'s (2000; see Figure 1.2) study exercised at 60% $\dot{V}O_2$ max for 30 minutes, and affective responses were recorded using the FS and FAS at 5-minute intervals throughout exercise, as well as before and after exercise. Initial analyses indicated that the *average* valence responses appeared unchanged during exercise, yet closer analysis revealed that they varied considerably between individuals. Specifically, 44% reported a progressive improvement in valence, whereas 41% reported a progressive decline. These divergent trends had resulted in the statistical conclusion that there was 'no significant difference'. Van Landuyt et al.'s (2000) research drew attention to the importance of close investigation of data prior to statistical analysis and the importance of not relying solely on means-testing when exploring affective responses to exercise.

This observed interindividual variation during exercise at an intensity that has traditionally been categorised as 'moderate' (i.e., 60% $\dot{V}O_2$max) calls for the need to re-examine published research that has investigated affective responses during exercise for similar divergent trends to those found by Van Landuyt et al. (2000). This need is particularly paramount for studies that have investigated participants with a lower activity status than the participants in Van Landuyt et al.'s (2000) study as they would be more representative of the general population. Understandably, this widespread reanalysis of data is unlikely to happen as it is somewhat idealistic to expect that exercise psychology researchers will be driven to re-examine their work when it has already been published. However, with access to some unpublished data (Welch, 2001), it was possible to perform some exploratory analyses into the individual variability of affective responses during exercise at two different intensities, and the role of activity status in that variability. Individual differences in both magnitude and direction of during-exercise affective valence responses were of particular interest in this re-analysis of the data.

Methods

Participants

Participants (n=16) were self-reported "active" (n=8) and "inactive" (n=8) female students. Activity status information was collected via an addendum to a medical questionnaire that was completed during participants' first laboratory visit. They were asked to indicate how frequently and how long they participated in physical activity and whether this had been typical behaviour over the last six months. The question regarding "typical behaviour" was included to ensure that the recorded activity behaviour was not a new behaviour. "Active" individuals were defined as those who regularly exercise for 20 minutes or more at least three times a week, and "inactive" participants were those who engaged in one or less 20 minute bouts of aerobic exercise per week. These selection criteria were justified by the fact that similar studies had previously categorised activity status in a similar way (cf. Parfitt et al, 1996; Parfitt et al, 1994). The participants were approached directly by the researcher and asked to volunteer for the study. This method of recruitment was used as a specific population was required (i.e. active and inactive females). All participants gave informed consent before participating in the study.

Table 2.1. **Means (M) and Standard Deviations (SD) of Participants' Descriptives.**

	Active (8)		*Inactive (8)*		*Total (16)*	
Descriptives	**M**	**SD**	**M**	**SD**	**M**	**SD**
Age (yrs)	20.14	1.57	20.44	1.24	20.31	1.35
Height (cm)	167.43	6.75	167.78	4.89	167.63	5.57
Body mass (kg)	66.18	5.90	70.58	12.48	68.66	10.10
Estimated VO_2max ($ml.kg.min^{-1}$)**	45.35	6.50	30.18	5.67	36.70	8.74
Self-reported activity (days)**	3.57	.79	1.11	1.27	2.19	1.64

***Independent t-tests revealed significant differences between groups ($p < .01$).*

Measures

Heart rate, monitored and recorded continuously using a short range telemetry HR monitor (S610i, Polar Electro Oy, Kempele, Finland), was used to determine exercise intensity. Age-predicted maximal heart rate was calculated (220-age) and the heart rate that the participant was required to exercise at was calculated in terms of a percentage of this value.

Perceived Exertion. The Rating of Perceived Exertion scale (RPE; Borg, 1998; see Appendix 3) was used as a measure of whole-body ratings of perceived exertion during exercise. The RPE is a 15-point scale ranging from 6 to 20, with anchors ranging from Very, very light (7) to Very, very hard (19).

Affect was measured using Hardy and Rejeski's (1989) Feeling Scale (FS) (see Appendix 4). The FS is a single-item 11-point measure of affective valence (pleasure/displeasure), ranging from +5 to -5, with verbal anchors at all odd integers and at the zero point (+5 = *very good*, +3 = *good*, +1 = *fairly good*, 0 = *neutral*, -1 = *fairly bad*, -3 = *bad*, -5 = *very bad*). Van Landuyt et al. (2000) found that the scale exhibited correlations ranging from .51 to .88 with the Valence Scale of Lang's (1980) self-assessment manakin, and from .41 to .59 with the Valence Scale of Russell, Weiss, and Mendelsohn's (1989) Affect grid.

Procedure

Exercise testing was done on an individual basis in an exercise physiology laboratory using a three-phase protocol: introduction and estimated aerobic power, and two experimental conditions. All three phases were conducted on separate days and at similar times. Confidentiality was maintained by allocating each participant a number.

Session one: Introduction and Estimated Aerobic Power Test.

Upon entering the laboratory participants were given a brief description of the tasks to be performed and were asked to fill out a medical questionnaire, sign a statement of informed consent and put on a heart rate monitor. Age, height, weight, resting heart rate and activity status were also recorded before taking part in the experiment. This procedure was followed by a 6 minute estimated aerobic power test on a cycle ergometer using the protocol described by Astrand and Rodahl (1986). Participants were required to pedal at a constant 50 rpm with a fixed weight in the first 2 minutes. Cadence was monitored using a digital display on the cycle ergometer. Following the first 2 min, adjustments to the weight were made depending on the heart rate at the end of each subsequent minute (weight increased if heart rate <139 bpm; weight decreased if heart rate > 150 bpm) until the end of the sixth minute. The average heart rate in the fifth and sixth minute was taken as the steady-state heart rate. Calculation of maximal oxygen uptake was made from these submaximal heart rate values using Astrand and Rodahl's (1986) adjusted nomogram.

Session two: Condition 1

The first experimental trial took place approximately one week after the estimated power test. When participants entered the laboratory they were asked to put on a heart rate monitor and sit quietly for a few minutes to allow their heart rate to decrease to a resting level. The trial consisted of participants exercising on a treadmill at either the low (50-55% maximal HR; HRmax) or high intensity (80-85% HRmax) for 20 minutes. Intensities of 50-55 and 80-85% maximal heart were chosen as these were classified as light- and heavy-intensity by the American College of Sports Medicine guidelines (ACSM, 1995). The exercise duration chosen was 20 minutes as this is the minimum amount of aerobic exercise the ACSM (1995) recommended to elicit beneficial cardiovascular responses within an exercise programme.

Conditions were counterbalanced so that half of the participants exercised at low intensity in Condition 1 and high intensity in Condition 2, and the other participants completed them in the opposite order. A3 size copies of the FS and RPE scales were put on a wall in front of the treadmill so that verbal recordings could be taken from the participant throughout the experiment. Heart rate was constantly monitored and recorded prior to exercise, every 5 minutes during exercise, and 5 minutes after exercise. RPE was also recorded every 5 minutes during exercise, and FS scores were taken pre-exercise and 10 minutes after the start of exercise. At the end of the exercise trial the participant was asked to stand quietly on the treadmill before again providing FS scores. From the moment the first recordings were taken to the time the last recordings were taken, the researcher only spoke to the participant in order to obtain RPE and FS scores.

Session three: Condition 2

This session took place approximately one week after condition 1 at the same time of day, and followed exactly the same procedure with the exception that the alternative workload was prescribed for each participant. That is, if the participant exercised at low intensity (50-55% HRmax) during the first experiment, they exercised at the high intensity (80-85% HRmax) in Condition 2, and vice versa.

Results

The data in this study was collected by the author at Sheffield Hallam University, UK, in partial fulfillment of the requirements for a Bachelor of Science degree (Welch, 2001). Results of the analyses that were performed for the original study will be presented first, followed by results of the present re-analyses of the data which were performed to explore individual differences in magnitude and direction of during-exercise affective responses.

Table 2.2.**Means and Standard Deviations (SD) of FS ratings for the Condition (exercise intensity) x Time (pre-, during and post-exercise) interaction across activity groups.**

Intensity Condition	Pre-exercise (SD)	During-exercise (SD)	Post-exercise (SD)
Low (50-55% HRmax)	1.81 (2.01)	2.13 (1.96)	2.88 (1.41)*
High (80-85% HRmax)	1.44 (1.75)	1.25 (1.77)	2.75 (1.61)**

*Significant differences pre- to post-exercise ($p < .05$)
**Significant differences pre- to post-exercise ($p < .01$)

Original data analyses involved a three-factor, Group (active vs. inactive) x Time (pre- vs. during- vs. post- exercise) x Condition (50-55 vs. 80-85% intensity) analyses of variance (ANOVA) on the affect data, with repeated measures on the time and condition data. Results failed to show any significant effect for time, time x group, condition, condition x group, or time x condition x group. The only significant effect was for the condition x time interaction ($p < .05$), which was indicative of significant improvements in affective valence from pre- to post-exercise in across group and conditions. No significant differences in RPE scores across time or group were observed.

Re-analysis of the data to investigate individual differences.

Closer inspection of the means and standard deviations in Table 2.2 revealed that there appeared to be a wide range of FS ratings at every time-point. Taken into consideration with the small sample size in this study, further analysis of activity status trends across time is warranted in order to truly explore individual differences in affective responses.

Firstly, of the 8 active participants, 4 reported improvements in affect, 2 remained the same and 2 declined from pre- to mid-exercise in the low intensity condition. Of those, affective responses improved from mid- to post-exercise in 3 participants and remained the same for the other 5. Inactive participants responded similarly to the low-intensity condition, with 4 reporting improved affect pre- to mid-exercise, 3 remained the same and 1 declined. From mid- to post-exercise, 5 of the 8 inactive participants reported improved affect, 2 remained the same and 1 declined. In the high-intensity condition, 2 active participants reported improved affect from pre- to mid-exercise, 2 stayed the same and 4 reported declines. From mid- to post-exercise, 7 of the 8 active participants reported improved affect with only 1 participant's level of affect remaining the same. In the same high-intensity condition, low-active participants also reported a wide range of directional affective changes from pre- to mid-exercise, with 2 reporting improvements, 1 reporting no change and five reporting declines in affect. From mid- to post-exercise in the high-intensity condition, 5 inactive participants reported increased affect, 2 remained the same and only 1 reported a decline.

Whilst there appears to be little to distinguish between active and inactive groups in variability in the direction of affective responses, further analyses revealed that the range of responses did appear to differ between groups. Of particular interest was the observation that whilst there were no mean differences between active and inactive females' affective states *during* exercise in either condition, the range of scores was much greater amongst the inactive sample than the active sample. In addition, active participants' responses always remained on the positive side of neutral, whereas a number of inactive participants reported negative affect during both exercise bouts (see Figure 2.1).

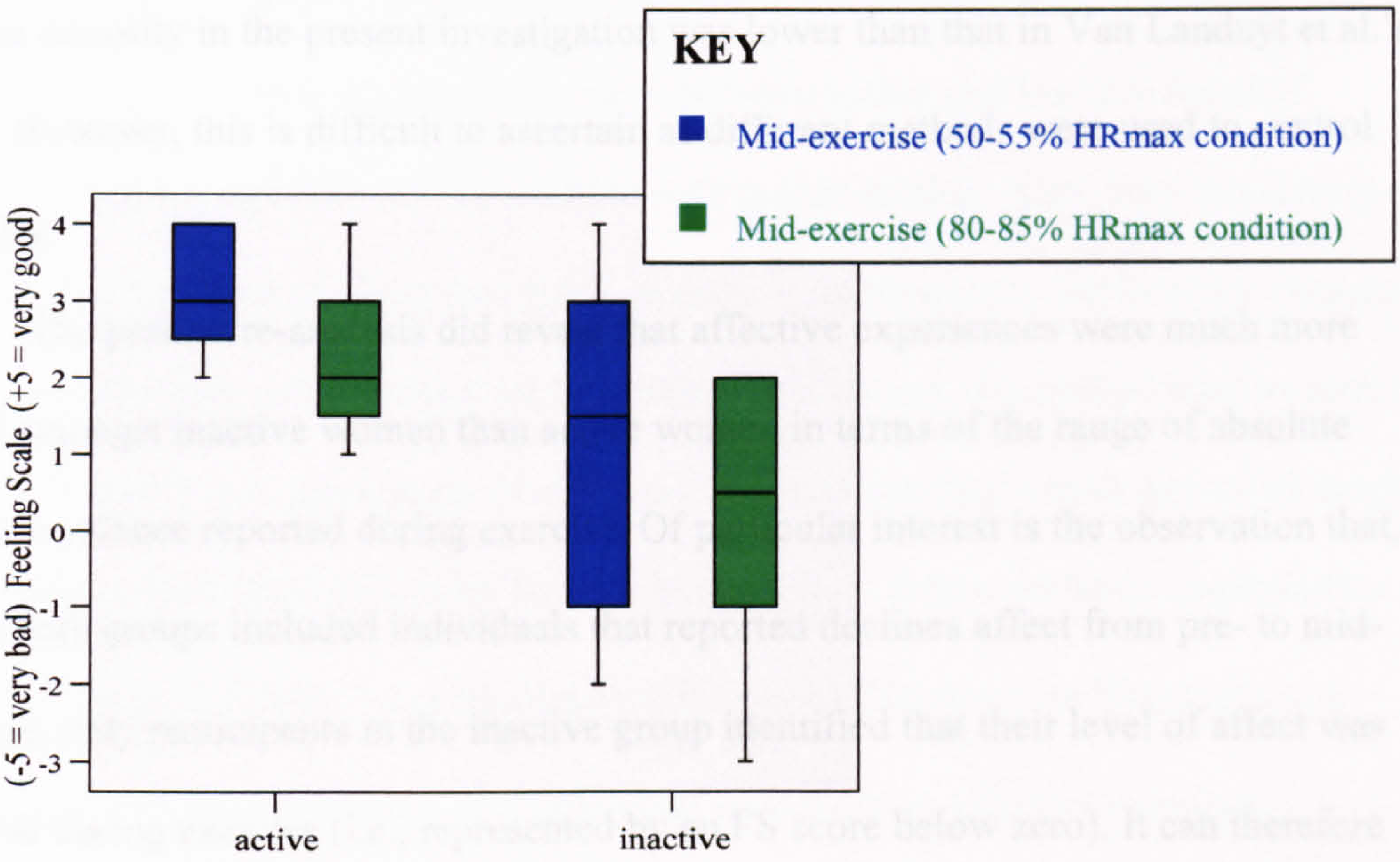


Figure 2.1 **Range of affective valence responses of active and inactive women during low intensity (50-55% HRmax) and high intensity (80-85% HRmax) exercise of 20 min duration.**

Discussion

The main objective of the present study was to explore whether variance in affective responses during either low or high-intensity exercise may differ based upon activity status. In order to achieve this objective, re-analysis of the raw data from a previous investigation (Welch, 2001) was performed taking into consideration variability in both the direction and range of responses.

Results indicated that comparable interindividual variance was observed amongst both active and inactive participants in the direction of affective responses from pre- to mid-exercise and mid- to post-exercise in response to both high and low-intensity conditions. Coupled with the small sample size in this study (likely resulting in a loss of power), this variance could explain the lack of statistically significant changes across time and condition as a function of activity status that were reported by Welch

(2001) prior to this reanalysis. In comparison to Van Landuyt's (2000) investigation, it is notable that a lower ratio of participants reported a decline in affective valence from pre- to mid-exercise during the low-intensity condition. This could be due to likelihood that the intensity in the present investigation was lower than that in Van Landuyt et al.'s study. However, this is difficult to ascertain as different methods were used to control intensity.

The present re-analysis did reveal that affective experiences were much more varied amongst inactive women than active women in terms of the range of absolute affective valence reported during exercise. Of particular interest is the observation that, whilst both groups included individuals that reported declines affect from pre- to mid-exercise, only participants in the inactive group identified that their level of affect was *negative* during exercise (i.e., represented by an FS score below zero). It can therefore be tentatively suggested that inactive participants may be more likely to truly respond "negatively" during exercise of both low and high intensity in comparison to active participants' "less positive" responses. It is arguable that the range of responses depicted in Figure 2.1 indicates that interindividual variability may also be a characteristic of affective valence during *high* (as well as low) intensity exercise within a low-active sample. If upheld by direct empirical investigation using metabolic demarcations to define exercise intensity, this observation would contradict one of the main tenets of the dual-mode model (Ekkekakis, 2003) – namely that affective valence responses within the severe intensity domain are believed to be homogeneously negative. Considering that Ekkekakis' theorising is based on direct empirical evidence from only healthy, active participants, further investigation of the model's tenets with a low-active sample is clearly necessary.

Limitations and future research directions

Considerable methodological limitations make it difficult to draw substantive conclusions or to compare the variance of responses in the present study to those reported by Van Landuyt et al (2000). At the outset, the sample size in this study was clearly too small to tease out any differences between active and inactive females' affective valence responses during exercise with means-testing. Also, only one during-exercise measurement of affect was made, making it impossible to explore any changes that occurred whilst participants were exercising. In addition, the method used to control exercise intensity (i.e., percentage of age-predicted maximal heart rate) was much more susceptible to individual difference factors than the more robust methods employed by Van Landuyt et al. (2000; i.e., percentage of $\dot{V}O_2$ max). However, as Ekkekakis and Petruzzello (1999) suggest, any interindividual variability in affective responses observed in research that uses percentages of maximal capacity to define intensity may be due to varying metabolic responses to these intensities. Therefore, future research that seeks to directly investigate interindividual variability of affect should control for physiological differences in response to exercise loads by using metabolic demarcations (e.g., the ventilatory threshold) to determine exercise intensity. Future investigations should also endeavour to explore the full spectrum of affective responses by employing measures to assess activation as well as valence responses.

In conclusion, whilst some of the variance observed in this study may be explained by methodological flaws, including the inaccurate method used to control intensity, it is indisputable that the phenomenon illustrated in Figure 2.1 (i.e., the large interindividual variability of inactive females' affective responses during both high- and low-intensity exercise) needs to be investigated systematically. This need is paramount if the mechanisms underlying during-exercise affective responses of habitually low-active individuals are to be fully understood. The subsequent studies in this thesis have been designed specifically to explore this concept further by controlling for the methodological limitations of this and other previous exercise-affect investigations.

Chapter Three: General Methods for Studies Two, Three and Four

Participants

Low-active female students and staff members from a large British university volunteered to participate after replying to poster or e-mail adverts. To be eligible, participants were required to be aged between 18-35 years and have participated in less than 2 exercise sessions (of > 20 min per session) per week for at least 1 year. Participants were also required to be non-smokers and non-asthmatic due to the exhaustive nature of session 2. Ethical approval for the study was granted by the Faculty of Biological Sciences Ethics Committee at the University of Leeds (see Appendices 1 & 2 for the medical screening and informed consent forms that were used).

Measures

Equipment.

All exercise tests were conducted in a laboratory on a computer controlled electro-magnetically braked cycle ergometer (Excalibur Sport, Lode BV, Groningen, The Netherlands). Throughout the duration of these tests, heart rate (HR) was monitored and recorded continuously using a short range telemetry HR monitor (S610i, Polar Electro Oy, Kempele, Finland). As an additional safety measure, arterial oxygen saturation (SaO_2) was also monitored continuously in the first two exercise tests using finger pulse oximetry (Biox 3745, Ohmeda, Louisville, USA).

Perceived Exertion.

The Rating of Perceived Exertion scale (RPE; Borg, 1998; see Appendix 3) was used as a measure of whole-body ratings of perceived exertion during exercise. The RPE is a 15-point scale ranging from 6 to 20, with anchors ranging from *Very, very light* to *Very, very hard.*

Affect.

Affect was measured from the perspective of the circumplex model (Russell, 1980) using two independently validated single-item scales: the Feeling Scale (FS; Hardy & Rejeski, 1989; see Appendix 4), and the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985; see Appendix 5). The FS is a single-item 11-point measure of affective valence (pleasure/displeasure), ranging from +5 to -5, with verbal anchors at all odd integers and at the zero point (+5 = *very good*, +3 = *good*, +1 = *fairly good*, 0 = *neutral*, -1 = *fairly bad*, -3 = *bad*, -5 = *very bad*). Van Landuyt et al. (2000) found that the scale exhibited correlations ranging from .51 to .88 with the Valence Scale of Lang's (1980) self-assessment manakin, and from .41 to .59 with the Valence Scale of Russell, Weiss, and Mendelsohn's (1989) Affect grid. The FAS of the Telic State Measure (Svebak & Murgatroyd, 1985) is a single-item measure of perceived activation, with participants asked to rate themselves on a 6-point scale ranging from *low arousal* (1), to *high arousal* (6). Van Landuyt et al. (2000) found that this scale exhibited correlations ranging from .45 to .70 with the arousal scale of Lang's (1980) self assessment Manakin, and from .47 to .65 with the Arousal Scale of Russell et al.'s (1989) Affect Grid.

Attentional Focus.

Participants rated on a 10-point bipolar scale (see Appendix 6) to what extent their thoughts were primarily associative or dissociative throughout the section of exercise just completed. In line with the procedures outlined by Baden, Warwick-Evans, and Lakomy (2004), participants were fully briefed in the distinction between associative and dissociative thoughts, and all completed a brief manipulation check before commencing exercise to ensure that they were comfortable with the distinction (see Appendix 6). Visual assessment was assisted by separating the 10 points that make up the line and representing them as large blocks rather than the 1cm lines used by

Baden et al. (2004). The data are presented in terms of a 10-point scale, where the first point on the scale = 1 (very associative) and the last point = 10 (very dissociative).

Self-Efficacy.

Two scales were developed to assess self-efficacy perceptions in relation to the specific demands of the tasks participants were asked to complete in sessions three and four. One scale was designed to assess *pre-exercise* self-efficacy perceptions (see Appendix 7) and the other was designed to assess self-efficacy perceptions *during* the exercise bout (see Appendix 8). Both measurement scales were developed in accordance with guidelines set by Bandura (1997) and the recommendations of McAuley and Mihalko (1998). Participants' responses to both scales could range from 0% (not at all confident) to 100% (highly confident). Strength of self-efficacy was calculated as the average of all the items on each scale. Pre-exercise self-efficacy was assessed by a five-item measure that required participants to indicate their degree of confidence in their ability to successfully cycle for incremental intervals (10, 20, 30, 45, & 60 min) at a moderately fast pace without stopping. During-exercise self-efficacy was assessed repeatedly throughout exercise by a three-item measure that required participants to indicate their degree of confidence in their ability to successfully cycle for another 10, 30 and 60 min at a moderately fast pace without stopping. In order to facilitate data collection, each scale that was used to measure psychological responses during exercise (i.e., FS, FAS, RPE, attentional focus and during-exercise self-efficacy) was printed in large font on separate laminated A4 sheets.

Procedures

Each participant attended four sessions in an exercise physiology laboratory, all of which took place approximately one week apart. For the first two sessions, three researchers were present in the laboratory, whereas in the third and forth sessions only one researcher was in the laboratory with each participant. During the exercise tests in sessions 1 and 2 participants breathed through a mouthpiece connected to a low dead space (0.090 l), low resistance (<1.5 cm H_2O at 3 $l.s^{-1}$) turbine volume transducer for measurement of inspiratory and expiratory flows and volumes (Interface Associates, Laguna Niguel, CA, USA). The turbine was calibrated with a three-litre syringe prior to the start of each test across a range of different flow profiles. Respired gas concentrations (O_2, CO_2, and N_2) were continually sampled from the mouthpiece and analysed by quadrupole mass spectrometry (MSX, Morgan Medical, Kent, UK). Calibration of the quadrupole mass spectrometer was by two precision-analysed gas mixtures, which spanned the range of the inspired and expired gas concentrations. The time delay between the gas concentration and volume signals was determined automatically using algorithms specified by the manufacturers (MSX, Morgan Medical, Kent, UK). The electrical volume and gas concentration signals were sampled and digitised every 20ms by computer in order to determine breath-by-breath measurements of pulmonary gas exchange variables (e.g. O_2 uptake ($\dot{V}O_2$), and CO_2 output ($\dot{V}CO_2$), etc.) using the algorithms of Beaver, Wasserman, and Whipp (1973). Following cessation of the exercise tests the two precision-analysed gas mixtures were sampled to ensure constancy of the calibration and were found to be indistinguishable from the pre-experimental values.

Session 1

This was a familiarisation session and was necessary to ensure that participants felt comfortable with the laboratory equipment, experimental procedures and the skill of responding non-verbally (pointing) to the questionnaires during the experimental procedure. On arrival at the laboratory, each participant was greeted, given an overview of the procedures to be followed, and asked to read and sign an informed consent form (Appendix 2). The purpose of the study was described as an investigation of 'physiological and psychological responses to exercise'. This discussion was followed by the completion of a medical and physical activity history questionnaire (Appendix 1), and measurement of height and weight. Participants also agreed at this point that they would not drink any alcohol for 48 hours prior to the next exercise session. A resting 3-lead ECG was taken and checked by the Laboratory Director for abnormalities prior to the commencement of the second session. The participant was then fitted with a heart-rate (HR) monitor. Once the integrity of the signal from the monitor was established, each participant was familiarised with a battery of questionnaires that included the FS, FAS, RPE and the attentional focus measure. When it was established that they understood each scale and how it would be administered during exercise, participants were shown to a cycle ergometer and presented with a verbal description of the exercise protocol. It was ensured that participants were comfortable with the protocol before being asked to sit on the cycle ergometer and fitted with a mouthpiece and nose clip. Participants then completed an exercise protocol identical to the one outlined for session 2 (below), but rather than continuing to exhaustion the exercise test was ceased and cool-down commenced when the participants' HR exceeded 140 bpm.

Session 2

This session involved a maximal Incremental Exercise Test to the limit of tolerance (IET). Participants were re-familiarized with the battery of questionnaires and fitted with a HR monitor. Participants then sat on the cycle ergometer and were fitted with a mouthpiece and nose-clip, and then resting values of physiological variables were monitored for 3-4 min. Once a resting steady state had been attained, participants were asked to begin cycling at 50rpm during a warm-up phase, which was conducted at a work rate of 20W (i.e. closely analogous to unloaded cycling). Following the attainment of a steady state during the warm-up phase (approx 3 min ± 55 sec duration) the incremental ramp phase was implemented without the knowledge of the participant. The work rate of the incremental ramp test increased as a linear function of time at a rate of $15W.min^{-1}$, during which participants were instructed to increase cadence to a level at which they felt comfortable (normally ≥ 60rpm), and this was continued until the participant could no longer maintain a cadence of >50rpm despite being encouraged to do so by the experimenter in charge. At this point the participant was deemed to have reached her limit of tolerance and the incremental phase was terminated. Sufficient participant effort was verified by determining the Respiratory Exchange Ratio (RER; the ratio of the net output of carbon dioxide to the simultaneous net uptake of oxygen) at the point of exhaustion. An RER > 1.1 was consistent with maximum effort by the participant, and in the absence of this response the test would have been repeated; however, this event never occurred in the current investigation. After attaining the limit of tolerance the load was removed from the cycle ergometer and a warm-down phase was conducted at 20W. This was continued for at least 6 min or until the participants' HR had dropped below 120 bpm.

HR, FS and FAS were measured before exercise (whilst sitting on the cycle ergometer prior to the mouthpiece and nose clip being fitted), every min during the IET, and at 0, 5, 10 and 20 min post-exercise (post-cool down, whilst the participant was recovering quietly in a chair). RPE was also measured every min during the IET and attentional focus was measured during the IET every other min (i.e., min 1, 3, 5 and so on). FS, FAS, RPE and attentional focus were measured by having participants point out their selections on poster-size versions of the scales which were placed directly in front of them. After each response, a research assistant repeated the participant's selection out loud to ensure that the information would be recorded correctly.

Sessions 3 and 4

These sessions were counterbalanced across the sample so that half of the participants completed session 3 first and the other half completed session 4 first. Both sessions involved the same exercise protocol, in the same laboratory, on the same cycle ergometer. However, they included one important instructional difference, which is outlined below. As in sessions 1 and 2, the exercise protocol for these sessions was pre-programmed on the cycle ergometer to ensure minimal interference from the researcher during the exercise bout itself.

On arrival at the laboratory participants were fitted with a heart rate monitor and re-familiarised with the RPE, attentional focus, FS and FAS scales. They were then introduced to and familarised with the two self-efficacy scales, after which HR was taken and they were asked to complete the FS, FAS, and pre-exercise self-efficacy scale. During session 3 participants were then given the following information pertaining to the exercise protocol: "After a gentle 2 minute warm-up, the workload will be increased to a moderate intensity. You will exercise at this intensity and maintain a comfortable rpm for thirty minutes. When thirty minutes are over, the workload will be decreased and you will complete a gentle warm-down for 4 minutes. There is a stop-clock in front of you which will show you how long you have been exercising for." At this stage during session 4 participants were given slightly different information; "After a gentle 2 minute warm-up, the workload will be increased to a moderate intensity. You will exercise at this intensity and maintain a comfortable rpm until I ask you to stop exercising. The exercise bout could last for anywhere between 5 minutes and 1 hour in duration. Though you are encouraged to continue exercising until you are asked to stop, you may stop at any time if you feel that you cannot continue for any reason. When you are given instruction that the exercise bout is over, the workload will be decreased and you will complete a gentle warm-down for 4 minutes." It was also ensured during session 4 that the participant was not wearing a wrist watch and that all clocks had been removed from the room. At this point in both sessions participants were also informed that the researcher would periodically come and ask them to respond to the battery of questionnaires whilst they were exercising, and that the rest of the time she would stand quietly out of sight at the other end of the room.

The exercise bout in both sessions involved a 2 min warm-up at a workload of 20W followed by 30 minutes at a workload equating to 90% of the individual's ventilatory threshold (VT), which was calculated using the data collected in session 2. During-exercise measures of HR, RPE, FS, FAS, self-efficacy and attentional focus were taken every 3 min (i.e. at min3, 6, 9, 12, 15, 18, 21, 24 and 27 of the 30-minute phase of the exercise bout), and the order in which the scales were presented to participants was alternated at each time point so as to negate the chance of acquiring an habitual response pattern. After 30 minutes the workload was reduced to 20W for a 4 min cool-down, and HR, FS, FAS and attentional focus measures were taken (min30). On completion of the cool-down, participants were instructed to stop pedalling and HR, FS, FAS were measured (post-0). Participants then stepped off the cycle ergometer and sat quietly in a chair for 10 minutes, during which HR, FS and FAS were measured at min 5 and 10 (post-5 and post-10).

It is important to highlight at this point that the consent form that participants signed during the familiarisation session outlined that they would be required to attend five sessions on separate days approximately one week apart, the last three of which would all involve exercise at the same intensity but would differ in duration. In reality all participants underwent only 4 sessions, yet it was ensured that this pretence was maintained throughout the testing period. They were misled as to the quantity of their involvement in order to obscure the main objective of study three. The intention was to discourage participants from attempting to guess the exercise duration of the unknown duration (UD) condition if they underwent the known duration (KD) condition first. If, for example, a participant believed that she still had a further 2 sessions left after she underwent the KD session, she would be less likely to anticipate the same exercise duration at the following session when she was told that the duration would be kept from her.

Interviews

All participants were asked during session 1 whether they would be willing to participate in two interviews if requested to do so. Therefore, 6 specifically-selected participants who had completed all four experimental sessions consented to and gave interviews that took place after sessions 2 and 4. The interviews were semi-structured and involved questions that explored the individual's experience (thoughts, feelings, perceptions) of the exercise bouts they had completed during the experimental period, and further questions about their physical activity history and attitudes. Full details of these interviews (including their objective) are outlined in Chapter Six, and the interview guide can be found in Appendix 9.

Participant Debriefing

Upon completion of their participation, all participants were given full information about the research objectives and why it was necessary to deceive them with respect to exercise duration and the number of sessions they attended. Participants were also given the opportunity to ask further questions, and, if it was requested, were given advice for personal exercise prescription based upon their physiological and psychological responses to the exercise in this research project.

Chapter Four: Study Two

Affective Responses of Low-active Women to a Maximal Incremental Exercise Test: A Test of the Dual-Mode Model.

Introduction

It is believed that a greater understanding of the relationship between exercise intensity and the affect experienced in exercise settings will ultimately provide an important step towards resolving the adherence problem (Van Landuyt, Hall, Ekkekakis, & Petruzzello, 2000). However, even though the exercise-intensity/affect relationship has received substantial research attention over the last thirty years, little conclusive evidence of a dose-response relationship had emerged until recently (Ekkekakis, 2003; Ekkekakis, Hall & Petruzzello, 2005a; Ekkekakis, Hall & Petruzzello, 2007). Ekkekakis (2003) argued that this inconclusiveness was the result of various methodological problems (e.g., inconsistent methods used to assess affect and exercise intensity) and the lack of a comprehensive theoretical framework. Thus, in a bid to explain the inconsistent results that afflict the exercise-affect literature, Ekkekakis's (2003) proposed the 'dual-mode model' as a theoretical depiction of the relationship between exercise intensity and affective response, so named because of the conceptualised dual influences on affective responses to exercise.

Specifically, Ekkekakis (2003) postulated that affective responses during exercise are the products of the continuous interplay between two general factors, both of which have access to the affective centres of the brain. These 'dual' mechanisms comprise, (a) relevant cognitive processes originating primarily in the pre-frontal cortex (involving such processes as appraisals of the meaning of exercise, goals, self-perceptions including self-efficacy, attributions, and considerations of the social context of exercise) and, (b) interoceptive cues from a variety of receptors stimulated by exercise-induced physiological changes. Although he asserts that these are two distinct processes, Ekkekakis (2003) maintains that neither mode is likely to have complete control over affective responses to exercise. Instead, the relative dominance and respective influence of these two mechanisms, and the way affective responses are manifested, vary across 3 distinct 'domains' of exercise intensity (Ekkekakis, 2003; Ekkekakis et al., 2005a); the basic tenets of which are outlined below:

Moderate Intensity = Below the ventilatory threshold (VT). Within this range, one can exercise for prolonged periods of time, as blood lactate concentration and oxygen uptake remain in a steady state and the capacity for sustained aerobic energy repletion is not exceeded. In this domain affective responses are expected to be primarily positive, with relatively low interindividual variability, and with cognitive factors having a low to moderate influence on affective responses.

Heavy Intensity = From VT to the level of critical power. In this domain, despite elevated blood lactate levels, exercise can be sustained for relatively prolonged periods, but with higher associated physiological stress than for moderate exercise (i.e., below VT). Affective responses are expected to exhibit marked interindividual variability, such that some individuals may report changes towards pleasure, whereas others may report changes towards displeasure. It is hypothesised that cognitive factors will have a strong influence on affect in this domain.

Severe Intensity = From the level of critical power to $\dot{V}O_2$ max. In this range, neither $\dot{V}O_2$ nor blood lactate can attain a steady state, and instead, both rise inexorably until exhaustion (Whipp, 1996). In this intensity domain it is suggested that interoceptive factors have an over-riding influence on affective responses, which are expected to be negative in most individuals.

The definition of these intensity domains is an important factor when one considers how intensity has typically been defined in past exercise psychology research. In fact, distribution of the normal range of VT extends from 35-80% of $\dot{V}O_2$ max (Whipp, 2004), and it has also been demonstrated that the onset of critical power can vary widely between 25 and 95% of the range from VT to $\dot{V}O_2$ max (Neder, Jones, Nery & Whipp, 2000). Understandably, therefore, the "common practice of reporting exercise intensity as a percentage of $\dot{V}O_2$ max [at heavy and severe intensities]" has been labelled as "fundamentally flawed" (Gaesser & Poole, 1996; p. 43).

The dual-mode model represents a crucial development as it could serve to explain the variability in results throughout the exercise psychology literature. However, empirical evidence for the theory to date is based largely on evidence from a small number of studies (Ekkekakis, 2003). In particular, Hall et al.'s (2002) findings played a significant role in the formulation of the dual-mode model. In this study all participants underwent a maximal incremental exercise test to exhaustion and affective responses were recorded every minute. Data indicated that during exercise activation increased steadily throughout the bout, but affective valence remained positive until after the ventilatory threshold, when a significant shift towards displeasure occurred. The decline in valence then continued until exhaustion. All participants in this study were regularly active, healthy university students and were therefore not characteristic of the majority of the population. To date, researchers have not tested affective responses to an incremental exercise test within a population that is habitually low-active. This need is of paramount importance given that the dual-mode model suggests that affective responses in the moderate (below VT) and heavy intensity (at and above VT) domains are susceptible to cognitive factors, such as self-efficacy beliefs and attributions, which are known to vary as a function of physical activity behaviour (e.g., McAuley & Blissmer, 2002).

The primary objective of the present study was to investigate whether a maximal incremental exercise test to volitional exhaustion (IET) with low-active participants would result in the same pattern of affective responses during exercise observed by Hall et al. (2002). As cognitive factors are thought to have limited influence on affect below

VT and responses are thought to be more positive and homogenous below this marker, it was hypothesised that the affective valence observed at the beginning of the IET would exhibit little variation and be maintained at least until VT is reached. Consistent with theory, changes in affective valence were also hypothesised to exhibit some interindividual variability from the point of VT or just above (as observed by Hall et al., 2002). However, due to the low-active status of the participants in the current study, it was anticipated that there would be a mean decline in valence at this point due to the probability of negative cognitive appraisal associated with the inexperience of exercise. Accordingly, it was hypothesised that affective change at very high intensities would be largely negative and exhibit little interindividual variability due to the over-riding influence of interoceptive cues.

A second purpose of the study was to assess whether, on cessation of exercise, the "instantaneous reversal from displeasure to pleasure that typically occurs in the *heavy* or *severe* ranges" (Ekkekakis et al., 2005a; p. 488) is also observed in a low-active population. According to Solomon (1980, 1991) this is the result of an affective opponent-process mechanism which functions to suppress or reduce all excursions from hedonic neutrality, and is brought into play whenever significant departures from affective equilibrium occur. This theory is consistent with Cabanac's (1971) theory about the physiological role of pleasure: that pleasure occurs whenever a sensation indicates the presence of a stimulus which helps to correct an internal trouble (e.g., high intensity exercise). In accordance with this premise, affective responses were hypothesised to decline progressively as work rate increased and rebound to more positive than baseline levels on cessation of exercise.

Finally, it has been demonstrated that cognitions during exercise (i.e., what one thinks about while exercising) can influence changes in feeling states. For example, Blanchard, Rodgers, and Gauvin (2004) found during a running experiment that only participants reporting dissociative-external thoughts (i.e., task irrelevant thoughts not relating to oneself) experienced significant improvements in selected feeling states pre- to post-running, and concluded that types of thoughts experienced may aid in explaining exercise-induced feeling states. When examining cognitions during exercise, researchers tend to distinguish between associative thought, which has been defined as focusing attention on stimuli related to the exercise, and dissociative thought, which has been defined as focusing on non-exercise related stimuli (Morgan & Pollock, 1977). With this in mind, and with the notion that the dual-mode model purports that within the severe intensity domain interoceptive cues become more influential on affective responses, it was hypothesised that participants' focus of attention would become increasingly associative as they become more aware of their physiological responses to the physical work they are doing and the associated sensations.

Methods

Participants

Table 4.1. **Descriptives for participants in study two.**

Descriptives	Mean ±SD
Age (yrs)	23.2 ± 4.38
BMI	24 ± 2.92
VO2peak (ml.kg.min-1)	33.6 ± 5.7
VT (ml.kg.min-1)	18.7 ± 3.5
VT (as % of VO2peak)	55.6%

Twenty low-active female students and staff members participated in the present study. Recruitment procedures can be found in Chapter Three.

Measures

Equipment and Physiological Measurements. Exercise tests were conducted in a laboratory on a computer controlled electro-magnetically braked cycle ergometer (Excalibur Sport, Lode BV, Groningen, The Netherlands). Throughout the duration of both tests, heart rate (HR) and arterial O_2 saturation (SaO_2) were monitored and recorded continuously using a short range telemetry HR monitor (S610i, Polar Electro Oy, Kempele, Finland) and finger pulse oximetry (Biox 3745, Ohmeda, Louisville, USA) respectively.

During the exercise tests participants breathed through a mouthpiece connected to a low dead space (0.090 l), low resistance (<1.5 cm H_2O at 3 $l.s^{-1}$) turbine volume transducer for measurement of inspiratory and expiratory flows and volumes (Interface Associates, Laguna Niguel, CA, USA). Full details of this equipment and calibration procedures can be found in Chapter Three.

Affect. Affect was measured from the perspective of the circumplex model (Russell, 1980) using two independently validated single-item scales: the Feeling Scale (FS; Hardy & Rejeski, 1989), and the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985). See Chapter Three for full details of these scales.

Attentional Focus. Participants rated on a 10-point bipolar scale to what extent their thoughts were primarily associative or dissociative throughout the section of exercise just completed. See Chapter Three for full details of this scale.

Perceived Exertion. The Rating of Perceived Exertion scale (RPE; Borg, 1998) was used as a measure of whole-body ratings of perceived exertion during exercise. See Chapter Three for full details of this scale.

Procedures

Each participant attended two sessions in an exercise physiology laboratory, during which three researchers (including the author) were also present. The first was a familiarisation session. This took place several days before the second session, which involved a maximal incremental exercise test to the limit of tolerance (IET). Affective responses were measured prior to, every min during and at min 0, 5, 10 and 20 min post-exercise. Perceived exertion was also measured every min during exercise, and attentional focus was measured every two min during exercise. The reader is directed to Chapter Three where full details of the procedures are described (see sessions 1 and 2).

Data Reduction and Analysis.

The breath by breath data were edited to exclude occasional errant breaths (>± 4SD of the local mean) which were the result of coughs or swallows, etc, and not considered part of the underlying physiological response (Lamarra, Whipp, Ward, & Wasserman, 1987; Rossiter, Howe, Ward, Kowalchuk, Doyle, Griffiths, & Whipp, 2000). Following this, the VT was identified using a validated cluster of ventilatory and gas-exchange variables (Beaver, Wasserman, & Whipp, 1986; Whipp, Wasserman, & Ward, 1986). That is, VT was identified as the point at which $\dot{V}CO_2$ accelerated out of proportion to the increase in $\dot{V}O_2$ (i.e., the V-slope method; Beaver et al., 1986). The point of VT was also confirmed using a valid cluster of ventilatory and gas exchange indices by identifying the point at which both the fraction of end-tidal oxygen ($F_{ET}O_2$) and the ventilatory equivalent for oxygen ($\dot{V}_E / \dot{V}O_2$) increase, concomitantly with a stable fraction of end-tidal carbon dioxide ($F_{ET}CO_2$) and ventilatory equivalent for carbon dioxide ($\dot{V}_E / \dot{V}CO_2$). This procedure was followed by two independent, experienced investigators, and in the event of significant disagreement the laboratory director was consulted to resolve any discrepancies (none arose in this study). $\dot{V}O_2$ peak (i.e., the peak rate of pulmonary oxygen uptake) was calculated as the average $\dot{V}O_2$ during the last 20 sec before attaining the limit of tolerance. See Figure 4.1 for diagrammatic representation of these methods used to identify VT.

Given that the duration of the IET varied between individuals, and in close keeping with the method of data analysis used by Hall et al. (2002), FS and FAS ratings made at the following seven time points during exercise were retained: the first min, the min before VT, the min of the VT, the 2 min following VT, and the last 2 min. Unlike Hall et al. (2002), min 2 data were not retained as for some participants this was also the min before VT was reached. No data were recorded during cool-down, both because the primary interest centred on responses *during* the IET and in order to reduce the number of data points in the repeated-measures analyses. For this latter reason, and in accordance with Hall et al. (2002), only the following data points were entered in statistical analyses: Min 1, the min before VT (VT-1), the min of VT (VT), 1 and 2 min after VT (VT+1 and VT+2), and the last min (End). Unlike Hall et al. (2002), it was deemed important to include both the min before and the min after VT in the analyses in order to investigate the potentially transient nature of affective responses surrounding VT as comprehensively as possible. Attentional focus ratings made at four time points were retained: Min 1 of exercise (Min 1), the min closest to VT (VT), 2 min following VT (VT+2), the last measurement recorded (End).

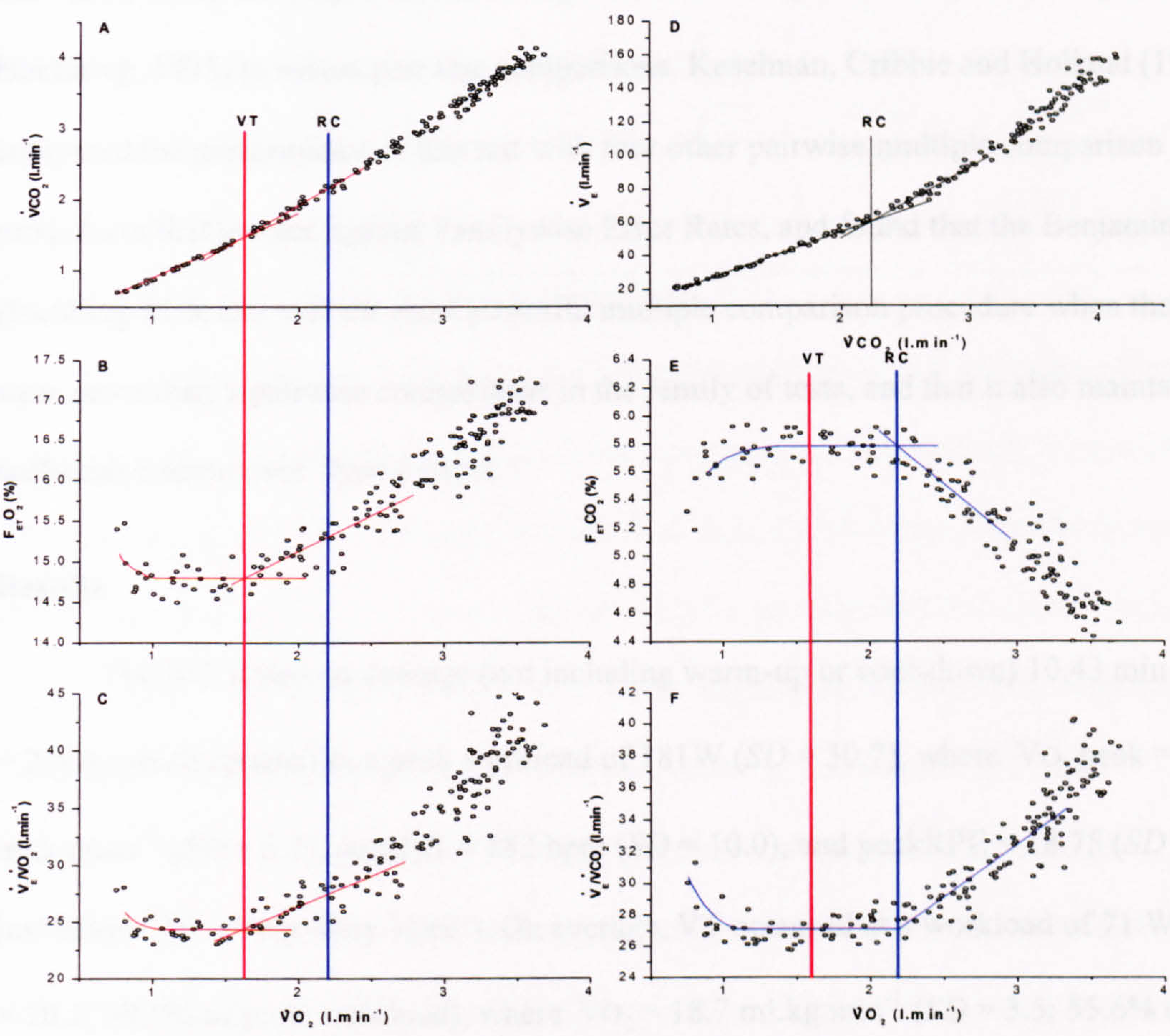


Figure 4.1. **Results from an incremental ramp test detailing the fitting strategy used to identify VT utilising (A) the V-slope technique, (B) $F_{ET}O_2$ and (C) the ventilatory equivalent for O_2 ($\dot{V}E/\dot{V}O_2$). Also shown is the fitting strategy used to identify respiratory compensation (RC) utilising (D) the relationship between $\dot{V}E$ and $\dot{V}CO_2$, (E) $F_{ET}CO_2$ and (F) the ventilatory equivalent for CO_2 ($\dot{V}E/\dot{V}CO_2$). (Figure reproduced from Ferguson, 2006, with kind permission).**

Two sets of statistical analyses were performed on the FS and FAS data. The first involved examination of change *pre- to post-exercise* across 5 time-points: Pre-, Post-0, Post-5, Post-10, Post-20. The second examined changes *during* exercise across 6 time-points for FS and FAS: Min 1, VT-1, VT, VT+1, VT+2, End. As attentional focus was only assessed every 2 minutes, changes across 4 time-points were examined: Min 1, VT (measurement taken closest to VT), VT+2 (the measurement that followed VT), and End (the last measurement taken). Separate repeated-measures analyses of variance (ANOVAs) were performed on each set of data for FS, FAS and attentional focus. Significant main effects were followed up with an examination of simple effects within each scale using the Benjamini-Hochberg False Discovery Rate test (FDR; Benjamini & Hochberg, 1995) to assess pairwise comparisons. Keselman, Cribbie and Holland (1999) compared the performance of this test with four other pairwise multiple comparison procedures that protect against Familywise Error Rates, and found that the Benjamini-Hochberg FDR test was the most powerful multiple comparison procedure when there were more than 5 pairwise comparisons in the family of tests, and that it also maintained sufficient control over Type I errors.

Results

The IET lasted on average (not including warm-up or cool-down) 10.43 min (*SD* = 2.03), which equated to a peak workload of 181W (*SD* = 30.7), where $\dot{V}O_2$peak = 33.6 ml.kg.min^{-1} (*SD* = 5.7), peakHR = 182 bpm (*SD* = 10.0), and peakRPE = 18.75 (*SD* = 1.6; just below '19 – Very Very Hard'). On average, VT occurred at a workload of 71 W (*SD* = 20.1; 39.5% of peak workload), where $\dot{V}O_2$ = 18.7 ml.kg.min^{-1} (*SD* = 3.5; 55.6% of $\dot{V}O_2$peak), HR = 136 bpm (*SD* = 12.7; 74.7% of peakHR), and RPE = 13.5 (*SD* = 1.9; just above 'somewhat hard' and 72% of peakRPE).

Pre- to Post-IET Affect Changes.

The first set of analyses examined changes in FS and FAS from pre-exercise to post-0, post-5, post-10, and post-20 (see Table 4.2). Repeated-measures ANOVAs revealed a significant main effect for time for both FS, $F(4, 68) = 3.02, p < .05, \eta^2 = .15$, and FAS, $F(4, 68) = 8.50, p < .001, \eta^2 = .33$.

Table 4.2. **Descriptive statistics (Means, SD) and effect sizes (Cohen's d) for FS and FAS change scores from pre- to post-IET time points.**

		$M \pm$ SD	Post-0	Post-5	Post-10	Post-20
FS	Pre	1.65 ± 1.87	0.08	0.36	0.63**	0.69**
	Post-0	1.79 ± 1.87		0.27	0.55	0.60
	Post-5	2.25 ± 1.55			0.29	0.36
	Post-10	2.68 ± 1.45				0.08
	Post-20	2.79 ± 1.51				
FAS	Pre	2.05 ± 1.00	1.20**	0.91*	0.52	0.41
	Post-0	3.29 ± 1.12		-0.39	-0.76*	-0.90**
	Post-5	2.90 ± 0.91			-0.42	-0.56
	Post-10	2.53 ± 0.91				-0.13
	Post-20	2.42 ± 0.84				

*: p <.05; ** p <.01 (based on Benjamini-Hochberg tests).

Post-hoc tests (see Table 4.2) for FS data revealed no significant change from pre-exercise to post-0 or to post-5, but significant increases from pre-exercise to post-10 ($p <$ .01) and post-20 ($p < .01$). Post-hoc tests for FAS data revealed significant increases from pre-exercise to post-0 ($p < .01$) and post-5 ($p < 0.05$), and significant declines from post-0 to post -10 ($p < .05$) and post-20 ($p < .01$). These results indicate that improvements in FS from baseline levels occurred only after 10 min of rest post-exercise, and that improvements remained apparent 20 min post-exercise. FAS results indicate that, although levels of FAS were elevated significantly from baseline levels in the first stages of recovery, they declined rapidly and had returned to levels similar to baseline by 10 min after exercise had ceased, and continued to decline throughout recovery.

During-IET Affect Changes

Repeated-measures ANOVAs revealed a significant main effect for time for both FS, $F(4, 72) = 31.05, p < .001, \eta^2 = .63$, and FAS, $F(4, 72) = 19.74, p < .001, \eta^2 =$

.52. Post-hoc comparisons (see Table 4.3) revealed a continual decline in FS throughout the IET, with significant differences in FS between Min 1 and VT-1 and every time-point thereafter ($p < .05$) until End ($p < .01$). Other notable declines in FS occurred between VT-1 and VT+1 ($p < .05$), VT and VT+2 ($p < .05$), VT+1 and End ($p < .05$), and VT+2 and End ($p < .05$). The only pairwise comparisons where no significant differences were revealed were between VT-1 and VT, VT and VT+1, and VT+1 to VT+2. These results demonstrate that a mean reduction in FS from the first min of the IET occurred prior to VT (at VT-1) and continued to decline as exercise intensity increased until volitional exhaustion. However, the lack of difference between VT-1 and VT, VT and VT+1, or between VT+1 and VT+2 indicates some stabilisation of FS across the ventilatory threshold. A much more pronounced decline is observed from VT+1 until the end of the IET.

Table 4.3. **Descriptive statistics (Means, SD) and effect sizes (Cohen's d) for FS, FAS, and Attentional Focus change scores during the IET.**

*: p <.05; ** p <.01 (based on Benjamini-Hochberg tests).
†: Data were not used for statistical comparisons.

		$M \pm$ SD	VT-1	VT	VT+1	VT+2	End
FS	Min1	1.95 ± 1.43	-0.40*	-0.62*	-0.81*	-1.02*	-2.05**
	VT-1	1.38 ± 1.49		-0.22	-0.42*	-0.62*	-1.74**
	VT	1.05 ± 1.54			-0.20	-0.40*	-1.56**
	VT+1	0.75 ± 1.59				-0.19	-1.39*
	VT+2	0.45 ± 1.57					-1.25*
	End-1†	-0.90 ± 2.34					
	End	-2.05 ± 2.44					
FAS	Min1	2.50 ± 0.88	0.49*	0.88*	1.01*	1.22*	1.79**
	VT-1	2.93 ± 0.92		0.37*	0.48*	0.74*	1.40**
	VT	3.25 ± 0.87			0.10	0.41*	1.15**
	VT+1	3.33 ± 0.80				0.34*	1.10*
	VT+2	3.63 ± 1.01					0.78*
	End-1†	4.25 ± 1.30					
	End	4.58 ± 1.44					
Attentional Focus	Min 1	6.83 ± 1.91		-0.90*		-1.86*	-2.35**
	VT	5.15 ± 1.93				-0.96*	-1.48*
	VT+2	3.32 ± 1.97					-0.53*
	End	2.28 ± 2.06					

Follow-up pairwise comparisons of the FAS data revealed a significant increase from Min 1 to every time-point during the IET ($p < .05$) until exhaustion. Thereafter, significant differences were observed for comparisons between every time-point analysed ($p < .05$), except from VT to VT+1. These results illustrate continual increasing activation levels throughout the exercise bout in response to increasing work rate, with some stabilisation just above VT. Close inspection of during-exercise standard deviation data (Table 4.3) indicates wide variability in FS values throughout the IET, with a larger value evident at the end of the IET than at any other time-point. In order to illustrate this phenomenon further, individual FS and FAS data at four different time-points are presented in Figure 4.4.

Attentional Focus Changes During the IET.

A repeated-measures ANOVA revealed a significant time main effect for attentional focus, $F(3, 54) = 26.56, p < .01, \eta^2 = .60$. Post-hoc comparisons revealed a significant reduction in values across each time-point during exercise ($p < .05$), which indicates that attentional focus was largely dissociative at the beginning of exercise (Min 1) and became progressively more associative as intensity increased (see Figure 4.3).

Discussion

The overall purpose of this investigation was to explore the affective responses of low-active women across increasing levels of exercise intensity, and examine whether data were consistent with the dual-mode model (cf. Ekkekakis, 2003). The main principles underlying this theory are that below VT changes in affective valence are likely to be homogenous and positive with low to moderate cognitive influence, and that just above VT (into the 'heavy' intensity domain[3]) there is more interindividual variability in valence responses due to the dominating influence of cognitive factors. As intensity

[3] The terms 'heavy' and 'severe' used in the discussion section refer to work rates conducted just above VT and at much higher work rates during the IET, respectively; i.e., those work rates that are *likely* to fall within these domains. The terms are placed within inverted commas because this test alone does not enable precise distinction between heavy and severe intensity domains.

increases further into the 'severe' domain, affective responses are theorised to become much more negative and exhibit little variability due to the over-riding influence of interoceptive cues. Attentional focus was also measured throughout the exercise bout to provide further insight into the suggested mechanisms behind affective responses to exercise at high intensities. However, this discussion will first consider the notion that an immediate rebound from negativity to positivity was expected to occur immediately on the cessation of intense exercise.

Pre- to Post-IET Affect Changes

Hall et al. (2002) reported that an immediate and rapid improvement in valence was observed on cessation of exercise, with a significant increase in FS scores from pre-exercise levels to post-0, and improvements continuing up to 20 min post-exercise. The present study generated slightly different findings as, compared to pre-exercise, FS scores did not improve significantly until participants had rested for 10 min. Although a significant increase in arousal from pre- to immediately post-exercise and a distinct shift from displeasure to pleasure was observed immediately on the cessation of exercise (thereby supporting Cabanac's, 1971 hypothesis and Solomon's, 1980, 1991, opponent-process theory), the improved valence change pre- to post-exercise was somewhat delayed. This indicates that low-active women may require more recovery time than active participants after high intensity exercise before any affective benefits of exercise become evident.

Changes during 'moderate' to 'heavy' intensity

Previous research using active individuals (Hall et al., 2002) revealed that activation increased throughout a maximal incremental exercise bout and affective valence remained positive until 2 min after the ventilatory threshold, when a significant and continual mean decline to exhaustion began. As expected, the results of the present study were consistent with Hall et al. in that activation increased progressively but, surprisingly, a mean decline in affective valence was initiated much earlier than the changes observed by Hall et al. (2002).

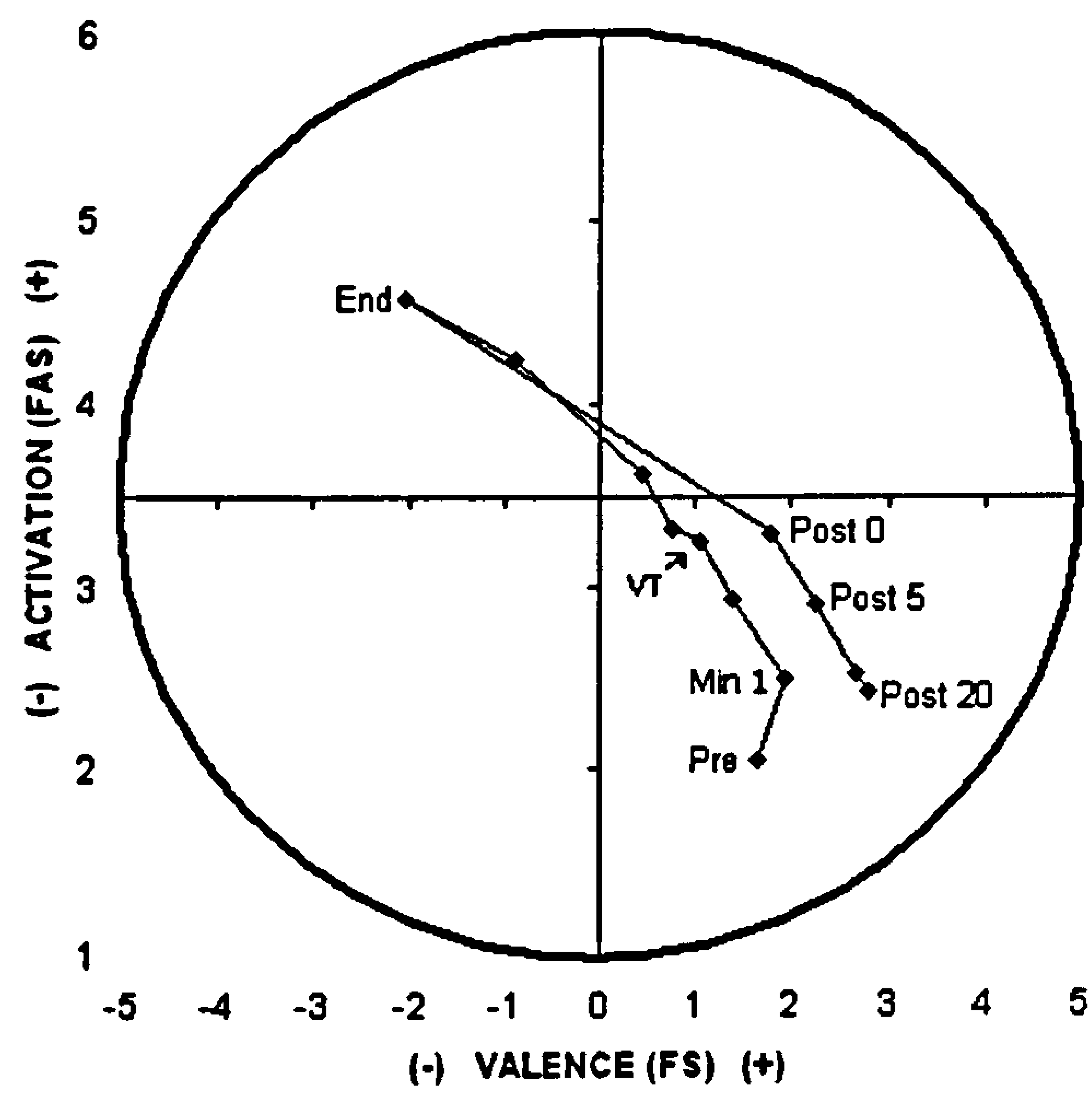


Figure 4.2. **Mean FS and FAS responses to an incremental exercise test to volitional exhaustion plotted in circumplex space.**

Closer inspection of data during the IET reveals that from Min 1 to just below VT (VT-1), 35% of participants reported a decline in FS, while most (60%) reported no change and only 1 participant (5%) reported improved affective valence. Above VT (at VT+1), most participants' FS scores were lower than at Min 1 (60%), with 35% reporting no change, and again improvements reported by only 5% of participants. In comparison, Ekkekakis et al. (2005a) re-analysed the data from the Hall et al. (2002) study and reported that from Min 2 to just after VT, 37.9% reported a decline in affective valence, 41.4% reported no change and 20.7% reported improved FS scores. Although Ekkekakis et al. (2005a) did not present distribution data for changes at or below the VT, these comparisons imply that within the 'heavy' intensity domain (just above VT) there is much more interindividual variability in terms of the direction of affective change amongst active participants than amongst the low-active participants in the present study.

Additionally, the estimated effect size (ES) of FS changes from Min 1 to VT in the present study was -0.62 (i.e., 'medium' according to Cohen, 1992), which is similar to the ES reported by Hall et al. (2002) for changes in FS from Min 2 to VT+2 (-0.67; ES reported for FS changes from Min 2 to VT was only -0.27). Comparatively, estimated ES for FS changes from Min 1 to VT+2 in the present study was much larger (-1.02). Interestingly, ES for changes in FS from VT to VT+2 were similar in both studies (present study = -0.40; Hall et al. = -0.42), which indicates that the main difference between active and low-active participants' affective responses across an incremental exercise bout occurred before VT was reached. At VT+2, low-active participants already exhibited a much more uniform negative response to exercise, yet showed signs of more interindividual variability in their valence responses at a slightly lower relative intensity than active participants. This detailed examination of the data also underscores that the lack of change, or 'stabilisation', between adjacent FS responses across the VT did not alter the overall pattern of decline in valence throughout the IET.

The mean decline in affective valence that occurred before VT suggests that, for low-active participants, affective change is not as homogenous and positive within the moderate intensity domain as suggested by Ekkekakis et al. (2005a), a finding that is supported by previous research (e.g., Parfitt et al., 1996). Due to the nature of the experimental situation and the fact that all participants were inexperienced exercisers, it seems that cognitive appraisal factors may exert a stronger influence on the control of affect at moderate intensities than is implied by the dual-mode model (which suggests only low to moderate influence of cognitive factors at this intensity). This conclusion seems logical when it is placed within the context of social cognitive theory (Bandura, 1986; 1997), which suggests that limited mastery opportunities (e.g., involving moderate intensity exercise experiences) will negatively influence a person's cognitions involving (a) the *self* and (b) task completion. Indeed, it is perhaps unsurprising that the participants in the present study (with their limited exercise experience) reported declines in affective valence even within the moderate intensity domain, an intensity that might be viewed by experienced exercisers as 'familiar' and/or 'comfortable'.

Changes during 'heavy' to 'severe' intensity

The more uniform negative response that occurred at and just above the ventilatory threshold illustrates that low-active individuals exhibited less directional variability in their valence response to 'heavy' intensity exercise than active participants did in Hall et al.'s (2002) study. Close inspection of the attentional focus data provides some insight into this phenomenon (see Figure 4.3). The types of thoughts participants had at VT were approximately halfway between fully associative and fully dissociative (M = 5.15). At VT+2 thoughts were much more associative (M = 3.32), which indicates that participants were thinking more about the exercise itself and sensations related to the exercise. It appears that, on average, participants held a greater awareness of the physical sensations of the physiological changes around the VT and beyond, which is likely to manifest itself in both the type of attentional focus reported and the affect experienced.

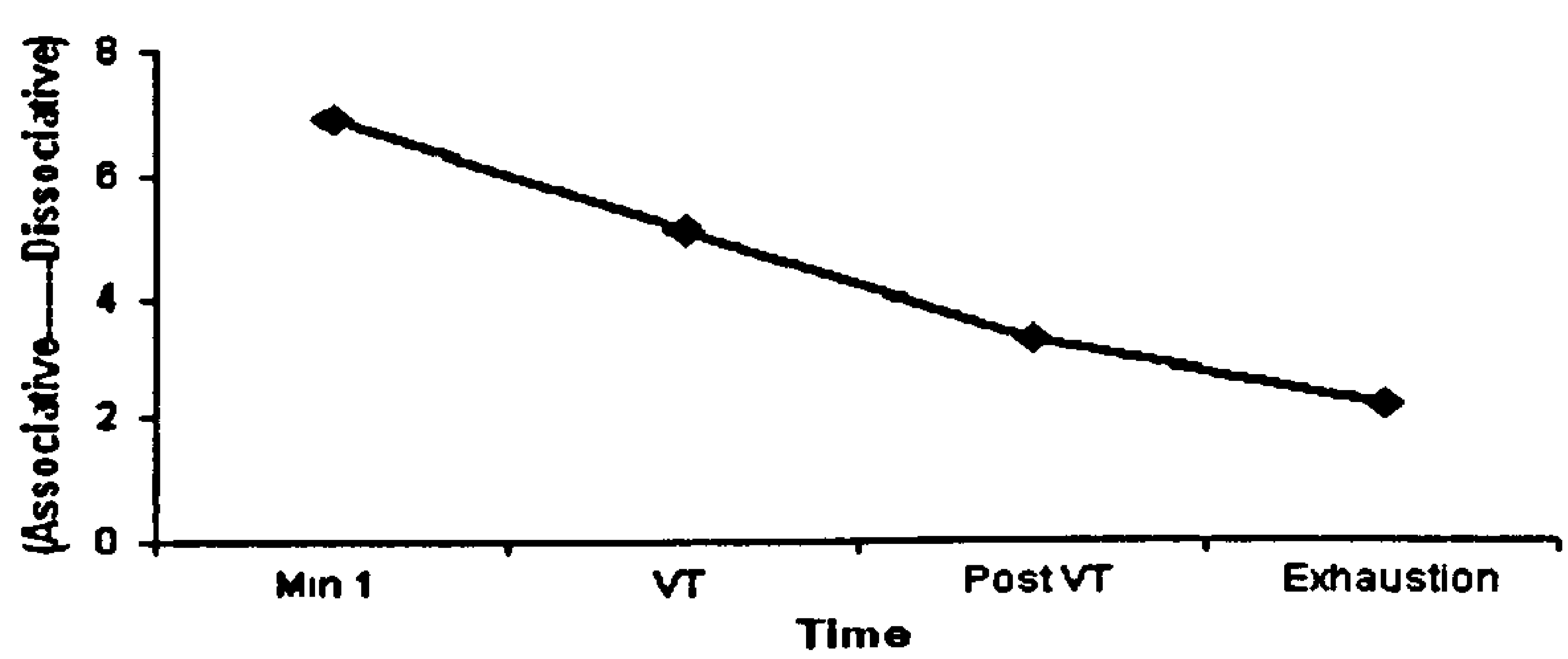


Figure 4.3. **Attentional Focus, plotted relative to the ventilatory threshold (VT), throughout an incremental exercise test to volitional exhaustion.**

As attentional focus was primarily associative and affective valence principally negative by VT+2, it is tempting to conclude that this indicates a strong influence of interoceptive factors within the 'heavy' intensity domain. However, these observations should not necessarily be interpreted as a departure from the dual-mode model. Although participant's perceived capabilities were not assessed, it is plausible to suggest that low-active women are likely to exhibit lower mean self-efficacy perceptions during exercise (cf. Bandura, 1997) than physically active women due to their relative inexperience of exercise and dealing with the associated physical sensations. Therefore, their affective responses to increasingly challenging exercise, according to the dual-mode model, would be expected to be more universally negative due to a more negative cognitive appraisal of *self*, the situation, and its unfamiliar sensations. It is also highly likely that critical power could occur at a lower absolute percentage of $\dot{V}O_2$ max in less fit individuals (Neder et al, 2000). Thus, although it is impossible to draw precise conclusions from the physiological data available in this study, it is plausible that participants had already reached the 'severe' intensity domain by the VT+2 time-point.

In light of these findings, it is initially confusing that such large standard deviations were evident at VT+2 and at the end of the exercise bout, particularly when the vast majority of participants (95%) reported a deterioration in affective valence and an increase in activation (85% of participants) from Min 1 to the last min of the IET. This observation unearths a potential pitfall associated with the examination of variability solely in terms of the *direction* of responses (i.e., movement along the valence dimension towards either pleasure or displeasure, or along the activation dimension in the direction of higher or lower activation). Individual variability may also be expressed in terms of the *magnitude* of change (i.e., how large the directional change is); a notion that could be an important factor in the pursuit of understanding interindividuality of affective responses to exercise and the mechanisms underlying this phenomenon. Inspection of Figure 4.4

reveals that although the *direction* of affective change reported was largely uniform across individuals at the higher exercise intensities (i.e., a decline from values reported during min 1), the *magnitude* of change exhibited substantial interindividual variability. For example, some participants reported a decline in valence of only one point on the Feeling Scale (e.g., from +1 to 0), whereas others reported more marked decline (e.g., from +1 to -5) from min 1 to the last min of the IET. This pattern was also somewhat evident in the activation data, which collectively results in a wide variety of affective profiles, clearly illustrated when individual results are plotted in circumplex space at VT+2 (Figure 4.4c) and, to a lesser extent at the last time-point during the IET (Figure 4.4d). It can therefore be suggested that whilst individuals exhibited little variation in the direction of change of their affective responses at high intensities, the magnitude of this change was diverse across individuals.

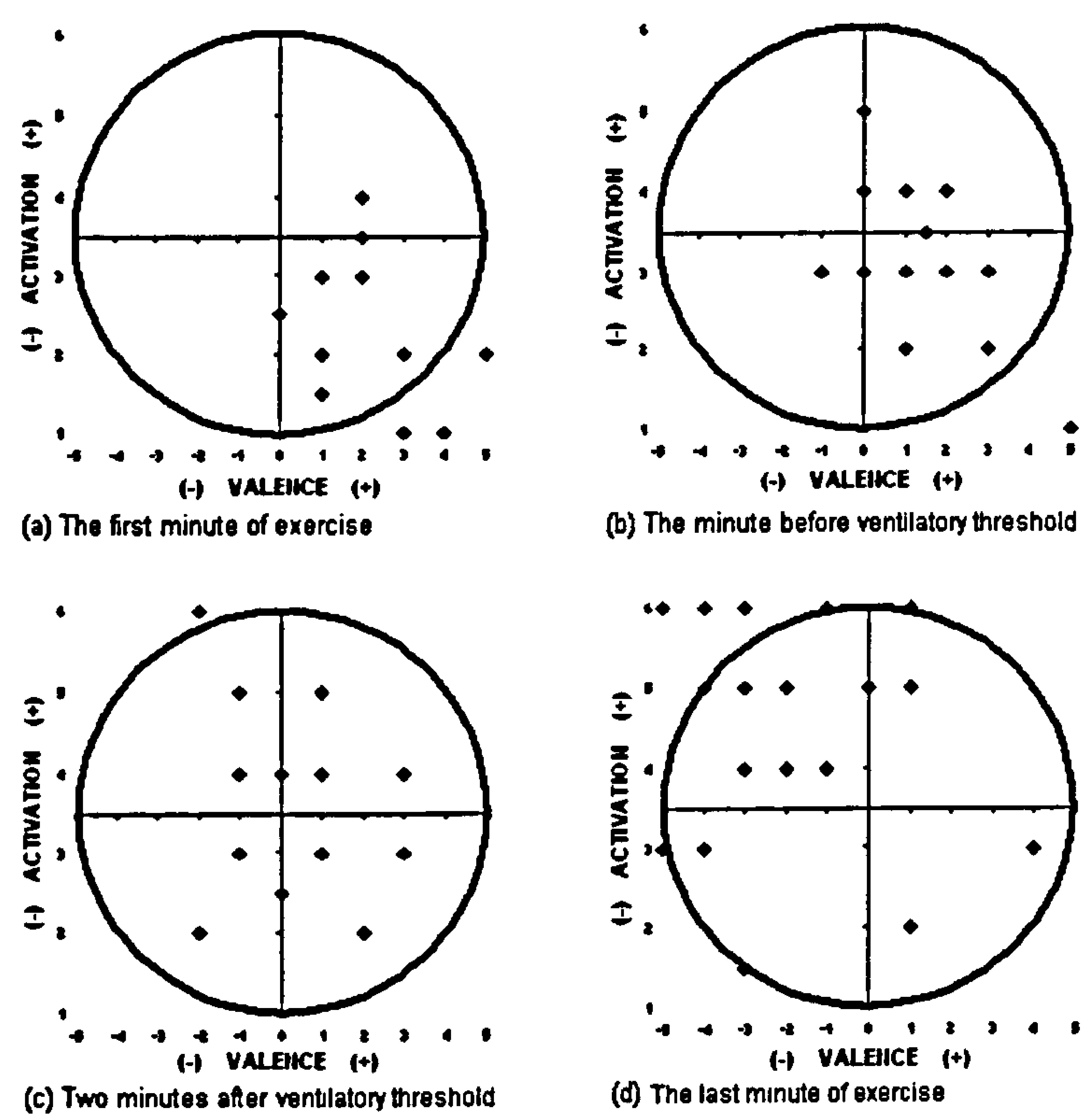


Figure 4.4. **Individual FS and FAS responses to an incremental exercise test to volitional exhaustion plotted in circumplex space at four different time-points.**

This type of variability could be explained to some degree by idiosyncratic response sets or error associated with the use of self-report measurement scales.

However, it is also important to consider that variability in the magnitude of response could be indicative of very different individual affective experiences, even in the 'severe' intensity domain. Notably, Hall et al. (2002) also report larger standard deviations for FS across the higher intensities (i.e., at 'VT+2' and at the 'End' of the IET) than at lower intensities, which implies that the active participants in Hall et al.'s (2002) study could also have exhibited considerable variability in terms of the magnitude of their response. Variance in the magnitude of responses is a detail that has been commented upon by previous researchers (e.g., Ekkekakis et al., 2005a; Van Landuyt et al., 2002; Ekkekakis & Petruzzello, 1999; Yeung, 1996) and clearly warrants further attention if we are to fully understand the extent of interindividuality of exercise-induced affect.

Conclusions

The dual-mode model (cf. Ekkekakis, 2003; Ekkekakis et al., 2005a) represents an important advancement in the field of exercise psychology research and practice, and provides a useful framework for comprehensive investigation of the dose-response relationship between exercise intensity and affect. Overall, this study upholds some and yet challenges other tenets afforded by this model. Results seem to point to a similarity in the transitional *pattern* of affective responses across intensity domains to that reported by Hall et al (2002), particularly with respect to the progressive increase in activation as intensity increased. There was also a rebound from negativity to positivity that occurred immediately upon cessation of the IET, in accordance with the dual-mode model. However, in comparison to baseline levels, valence improvement post-exercise was somewhat delayed. These results also suggest that the affective transition zones referred to by Ekkekakis et al. (2005a; i.e., from both positive to negative affect, and the shift from variability to homogeneity of responses) seemed to occur earlier within a low-active sample than an active one. This could have important implications for the interpretation of novice exercisers' affective responses to exercise within the moderate intensity domain. In addition, the results of the present study advocate that the term 'homogeneity' be used with caution when describing the affective response patterns of low-active participants at both moderate and severe exercise intensities. Findings illustrate that low-active participants reported a mean decline in valence below VT, but that they varied substantially in terms of *direction*, and that they also varied largely in terms of *magnitude* of change at intensities above and beyond the ventilatory threshold. This observation highlights the potential importance of *magnitude* of affective change as a significant feature of interindividual variability, and it is recommended that this becomes the subject of future investigation into affective variability during exercise.

Limitations and Recommendations for Future Research

This investigation revealed that a decline in affect occurred within the 'moderate' intensity domain of the IET. However, this conclusion should be adopted with some caution in light of the chosen methodology employed in this study. Observation of the FS mean values (see Tables 4.2 & 4.3) revealed that there was a slight increase from pre-exercise to Min 1 of the IET, which suggests that the warm-up of 20W influenced perceived affect, and therefore implies that the warm-up should have been considered as part of the experimental protocol. We chose not to standardise the duration of the warm-up (thereby making any data collected during this time incomparable across participants) as it was deemed more important that participants attained a physiological steady state prior to commencement of the IET to ensure a valid estimate of VT (Ozcelik, Ward & Whipp, 1999). It is entirely possible that the 20W warm-up represented 'moderate' intensity for some or all of the individuals in the present study, which should be an important consideration for future studies involving relatively inactive participants. That said, this does not alter the fact that there *was* an obvious difference between the responses of the low-active participants in this study below VT (i.e., the 'moderate' intensity domain according to the dual-mode model; Ekkekakis et al., 2005a) in comparison with previous studies that involved active participants (Hall et al., 2002; Bixby et al., 2001). A related problem with respect to the 'below VT' data was that this phase was very short for many participants due to their activity status, thereby restricting the investigation of transience of affect within this domain. In hindsight, the work rate increments chosen (i.e., $15W.min^{-1}$) were probably too large for this sample, and it is recommended that future similar investigations consider using smaller increments (e.g., $10W.min^{-1}$).

In addition, conclusions about the difference between the 'heavy' and 'severe' intensity domains in this study are difficult to draw out as it is only possible to infer where critical power may have occurred. Considering the substantial effect sizes reported for FS changes from VT+1 and VT+2 to the End of the IET, the onset of this metabolic demarcator with respect to affective change is clearly an important avenue for future research. It is also recommended that comparisons made to Hall et al.'s (2002) study are considered with regard to the fact that the IET in the present study was performed using a different protocol and mode of exercise. It would be interesting to investigate whether the same differences between active and low-active participants' perceptions would be observed if they were to perform exactly the same exercise protocol. It is also important to consider the fact that the sample for this study comprised a relatively small group of low-active women, which limits the extent to which the study's findings can be generalised to other populations. Future research should investigate whether this study's findings are repeatable across exercise modes and the gender divide.

Theoretical and Practical Implications

In spite of the above limitations, the present findings do make a number of important contributions, which span both theoretical advancements as well as practical considerations. From a theoretical perspective, three observations are worthy of note: (1) valence improvements on the cessation of exhaustive exercise in this study with low-active women were somewhat delayed; (2) cognitive factors could play as important a role in mediating the affective responses of novice exercisers to moderate intensity as they do to mediating affect during heavy intensity exercise; and (3) consistent with previous research (e.g., Hall et al, 2002), there seems to be a rapid decline in affective valence as exercisers make the transition into the 'severe' intensity domain.

With these points in mind, systematic investigation of the dual-mode model that takes into account magnitude *as well as* direction of affective responses to acute exercise seems warranted. In addition, future research should consider the potential impact of activity status and the social-cognitive consequences of inactivity upon perceived affect at work rates below VT, and upon immediate post-exercise affective responses. Furthermore, the finding that the affect experienced by low-active people can deteriorate during the course of an exercise bout advocates the need for researchers to reconsider the text-book consensus that for *most people* aerobic exercise is associated with feeling better (e.g., Landers & Arent, 2001). This need is paramount when we consider the fact that the majority of the population is inactive (WHO, 2004).

Given that all participants in this study were habitually low-active and that a mean progressive deterioration in perceptions of valence occurred before VT, results from the present study also have important applied implications for those concerned with health promotion. First, although pre- and post- appraisals of an exercise experience may provide some insight into peoples' exercise motives, it is essential for those concerned with fostering exercise maintenance to also consider novice exercisers' thoughts and feelings *during* the exercise experience. Second, the results of this study suggest that high intensity exercise may not yield the same *immediate* affective improvement post-exercise (in comparison to baseline values) for low-active people as are experienced by active individuals (e.g., Hall et al., 2002). From a cognitive-behavioural perspective, it seems plausible to suggest that inexperienced exercisers' thoughts and actions during the first 10 min of recovery could play an important role in forming their beliefs about intense exercise and their experience of it. One option may be to encourage those with limited exercise experience to attend to the more pleasurable sensations being experienced on *completion* of intense exercise rather than any negative sensations experienced *during* exercise. For example, emphasis could be placed upon the reinforcement of mastery beliefs (cf. Bandura, 1997) by concentrating on the achievement of completing the task.

Chapter Five: Study Three

Changes in Affect, Self-Efficacy and Attentional Focus in Response to the Perceptual Manipulation of a 'Moderate' Intensity Exercise Task.

Introduction

Recent research (Lind et al., 2005; Parfitt et al., 2006) suggests that individuals with little or no prior experience of physical activity, when given the choice, voluntarily elect to exercise at an intensity that corresponds with the ventilatory (or lactate) threshold (VT; i.e., 'moderate' intensity exercise). From a health promotion perspective these findings are encouraging, given the current guidelines that individuals interested in adopting physically active lifestyles should aim to engage in at least 30 min of *moderate intensity* activity on five or more days of the week (Department of Health; DOH, 2004; WHO, 2004; Pate et al., 1995). However, the results of study two revealed that women with limited recent exercise experience reported declines in affective valence *before* VT was reached during an incremental exercise test (IET). This evidence may be perceived as somewhat disheartening by health professionals as it indicates that inexperienced exercisers can respond negatively even to 'moderate' intensity exercise.

The early decline in affective valence observed in study two may be explained by Ekkekakis' (2003) dual mode model, which suggests that during 'moderate' and 'heavy' intensity exercise, affective valence responses are likely to be influenced by the individual's cognitive appraisal of the task at hand. Thus, given the lack of recent exercise experience of participants in study two, it is perhaps unsurprising that an early mean decline in affective valence was observed. With the importance of moderate intensity exercise in health promotion initiatives, it is clearly imperative to directly investigate the notion that cognitive appraisal influences affective responses during exercise at an intensity that approximates VT (Ekkekakis, 2003; Ekkekakis & Petruzzello, 2005a) within an low-active sample. If the dual mode model holds true, it is also necessary to investigate the influence of specific cognitive variables on participants' affective states during exercise at this intensity. The present study was therefore designed specifically to address these issues.

Before providing a rationale for these objectives, it is first important to recall that relatively few studies in the exercise-affect literature have employed metabolic demarcators to measure exercise intensity (Ekkekakis, 2003), which, according to the dual-mode model, makes it difficult to be sure of the mechanisms underlying affective change. Ekkekakis (2003) also highlighted that few studies have investigated affective responses that occur *during* exercise, and that the measures employed by researchers interested in these phenomena have varied widely. Nonetheless, some evidence exists to suggest that, (a) altering cognitive appraisal of the task is likely to influence during-exercise affect, and (b) specific cognitive variables, particularly self-efficacy (i.e., beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments; cf. Bandura, 1977, 1986, 1997) and attentional focus (i.e., the ratio of associative to dissociative thought patterns; cf. Morgan and Pollock, 1977), could be influential in governing affect during exercise at an intensity that approximates the VT. A concise discussion of the evidence linking these variables with affect is presented below, and the reader is directed to Chapter One (p. 29-36) for a more detailed exploration of the literature surrounding these issues.

Cognitive manipulation of the task and its influence upon affect, perceived exertion and attentional focus responses during acute exercise.

Recent studies have successfully altered participants' perceptions of exercise duration in order to investigate the influence of cognitive appraisal of the task upon affect and perceived exertion during exercise (e.g., Baden, McLean, Tucker, Noakes & St Clair Gibson, 2005; Baden, Warwick-Evans, & Lakomy, 2004). As a result, there is evidence to suggest that both affective and perceived exertion responses during exercise are influenced by the manipulation of an individual's awareness of the task duration.

For example, Baden et al. (2005) demonstrated that perceived exertion increased and affect decreased significantly from min 10 to min 11 during a 20-min exercise bout that sixteen trained male and female runners believed would last only 10 min. At min 10 participants were asked to continue running for a further 10 min. These changes were not observed in either of the other two exercise conditions (20 min of known duration and 20 min of unknown duration).

Baden et al. (2005) also investigated attentional focus during exercise, though found no difference in this variable between trials (reporting that it became increasingly associative as time elapsed in all conditions). Unfortunately, these authors did not report whether during-exercise affect, attentional focus and perceived exertion were statistically related. In a study that employed a similar design to Baden at al. (2005; devoid of an affect measure), Baden et al. (2004) found that runners reported more dissociative thoughts throughout exercise when they expected to run for longer (20 min versus 10 min), and that these thoughts were inversely correlated with perceived exertion. In explanation, the authors suggested that participants may have employed a more dissociative strategy in order to distract themselves from the physical symptoms accompanying longer duration exercise, which resulted in lower perceptions of exertion. As there were no 'relative' intensity data in Baden et al's (2004) study (only absolute treadmill speed was assessed), it remains unclear why there was a discrepancy between their results and those of Baden et al. (2005). However, it is possible that exercise at an intensity 75% of peak running speed was too high (and, therefore, too physiologically demanding) for Baden et al.'s (2005) participants to be able to employ a dissociative strategy.

Baden et al. (2004) also referenced the work of Ulmer (1996) to explain why altering perceptions of exercise duration influenced perceived exertion. Ulmer (1996) theorised that there is some kind of 'teleoanticipatory' mechanism (i.e., distance perception or consideration of a finishing point) governing the regulation of exertion during physical exercise. In this process, knowledge of the endpoint is used by the brain as the anchor for creating the particular algorithm for a particular exercise bout and moderating power output during the exercise bout. For example, the algorithm used by the brain in setting a particular pacing strategy will be very would be different for a 5km compared with a 100km running or cycling event (St Clair Gibson, Lambert, Rauch, Tucker, Baden, Foster & Noakes, 2006). St Clair Gibson et al. (2006) argue that this 'internal clock' mechanism is central to establishing a pacing strategy during exercise and for the regulation of fatigue. They also identified that the teleoanticipatory mechanism works together with memory of prior events of similar distance or duration, and knowledge of external (environmental) and internal (metabolic) conditions to set a particular optimal pacing strategy for a particular exercise bout. This is arguably an important concept both theoretically and practically as it suggests that those with limited exercise experience and knowledge of the sensations associated with exercise would be hindered in their ability to pace themselves. It is therefore plausible to suggest that within a low-active sample, lack of knowledge of exercise duration may not only influence *what* one feels (i.e., perceptions of exertion) but also *how* one feels (i.e., affective valence).

Although Baden et al. (2005) did not report any relationship between attentional focus and affect during exercise, there is evidence elsewhere to suggest that the two variables are linked. Blanchard et al. (2004) demonstrated that participants employing a dissociative-external attentional focus also reported significantly more positive and less negative feelings states post-exercise than other participants. Also, Harte and Eifert (1995) reported that when participants exercised with an external attentional focus, post-exercise mood responses were more positive than with an internal attentional focus. However, as these studies involved active, healthy participants and a pre- to post-exercise experimental design, it remains unclear whether attentional focus could influence the affective responses of inexperienced exercisers *during* a moderate-intensity exercise bout.

Self-efficacy and affective responses during acute exercise

To date, there has been considerable interest in the relationship between task self-efficacy and exercise-induced affect. Again, few of these investigations have measured affect during the exercise bout, which means that we still have a somewhat limited view of the true nature the relationship between these two variables during exercise at intensities that approximate the VT. There are some exceptions, however. McAuley and Courneya (1992) investigated feeling scale and perceived exertion responses to a graded exercise test (GXT) in 88 sedentary middle-aged participants. Pre-exercise self-efficacy explained 3% of variance in affect at the end of the GXT (70% HRmax). The authors concluded that a stronger efficacy-affect relationship should exist with exercise intensities above 70% HRmax. However, Tate et al. (1995) directly tested this hypothesis and found evidence to suggest that the efficacy-affect relationship during exercise weakened as intensity increased. In this study, pre-exercise efficacy significantly predicted approximately 6% of the unique variation in negative affect reported halfway through a 30 min exercise bout at 55% $\dot{V}O_2max$, but not at 70% $\dot{V}O_2max$, in a highly active sample.

The notion that high self-efficacy is related to more positive/less negative during-exercise affect also finds support from investigations that have manipulated self-efficacy. By providing participants with false feedback after an aerobic fitness test, both McAuley et al. (1999) and Jerome et al. (2002) manipulated the pre-exercise self-efficacy perceptions of low-active women before they engaged in 20 min of 'moderate' intensity exercise (RPE = 12-16). Both studies reported that, although there was a steady decline in affect throughout exercise, affect was higher in the high-efficacy groups than the low-efficacy groups. However, McAuley et al. (1999) identified that self-efficacy was related to affect during and after exercise only in the high-efficacy group, whereas Jerome et al. (2002) reported that self-efficacy and feeling states were unrelated. Bozoian et al. (1994) did not manipulate self-efficacy but divided 36 active females into two groups depending upon whether their pre-existing self-efficacy perceptions were above or below the group median. The more efficacious group reported having more positive feeling states than their low efficacious counterparts throughout and after a 20 min exercise bout at 70%HRR. In addition, low efficacy individuals experienced a significant reduction in revitalization during exercise before returning to baseline levels post-exercise.

Limitations of previous research

None of the previous investigations that manipulated perceptions of exercise duration in order to explore corresponding changes in psychological responses have either investigated whether attentional focus or self-efficacy perceptions accounted for variance in affect, or looked at these responses within a low-active sample. However, there is evidence in the literature to advocate that affect experienced during exercise is positively related to perceptions of self-efficacy (e.g., Tate et al., 1995). It is, nonetheless, difficult at this stage to draw conclusions about the importance of self-efficacy and the role it plays in governing affect, due to important methodological limitations of past research. The control of exercise intensity in these studies holds particular limitations. For example, the difference in affective responses between groups that Bozoian et al. (1994) observed could be attributed to the groups' different self-efficacy perceptions (as the authors concluded). However, according to the dual-mode model, the differences observed could equally be because at 70% of HRR participants were working at distinctly different *metabolic* intensities, thereby altering the relative influence that self-efficacy perceptions had upon affect. This observation highlights the notion that until these constructs are investigated within experimental designs in which metabolic indices of exercise intensity are controlled for, it will be difficult to ascertain the influence of self-efficacy and other cognitive variables upon affective responses.

Furthermore, the relationship between self-efficacy and affect has typically been investigated by assessing self-efficacy beliefs *before* the exercise bout began (e.g., McAuley & Courneya, 1992; Tate et al., 1995). It is important to remember that Bandura (1997) conceptualised self-efficacy as a situation-specific variable that alters with experience of the situation. Indeed, it has been consistently demonstrated that self-efficacy perceptions are likely to increase from pre- to post-exercise, and that these changes correspond with improvements in affect from pre- to post-exercise (e.g., Tate et al., 1995). Additionally, Bandura's theory indicates that the affective experience of physiological and somatic responses is likely to influence self-efficacy perceptions. The theory also states that the extent to which people alter their efficacy through performance experiences depends not only upon preconception of capability, but also upon perceived task difficulty and effort, which may change once an exercise bout begins and as it progresses (especially for inexperienced exercisers). Therefore, it seems reasonable to suggest that task self-efficacy could be a better predictor of affective valence *during* an exercise bout if it is measured *during* exercise, when the participant has immediate experience to draw upon and physiological/somatic sources of efficacy are likely to play a strong role.

The present study

It was with these limitations in mind that the objectives of the present study were developed; namely to (a) manipulate low-active female participants' perceptions of exercise duration in order to explore the influence that cognitive appraisal has on affective responses to acute bouts of aerobic exercise at the approximate point of VT (~VT), and (b) assess the influence of self-efficacy and attentional focus on affective responses during this exercise. Based upon theory (specifically 'dual-mode model' and 'self-efficacy theory'), and evidence from the previous investigations profiled above, the following hypotheses were addressed. First, low-active females' affective valence responses were expected to improve after a 30 min exercise bout at ~VT in comparison to baseline levels, irrespective of the participants' knowledge of exercise duration (i.e., cognitive appraisal of the task). Second, it was hypothesised that the pattern of these participants' affective valence responses during the exercise bout would vary as a function of their knowledge of the exercise duration. Specifically, during the known duration condition, participants would have the capacity to be able to anticipate the end of exercise, and it was expected that this would be reflected in less negative affective valence. Third, it was hypothesised that participants' self-efficacy perceptions would be lower and attentional focus (dissociative-associative thoughts) more associative during exercise when exercise duration was unknown compared to known. Finally, if support was found for the second and third hypotheses, these cognitive variables were expected to be positively related to affective valence and explain affective valence during exercise, and, in particular, self-efficacy measured during exercise would be a stronger predictor of affective valence than pre-exercise efficacy. In accordance with theory (Ekkekakis, 2003), it was also anticipated that there would be limited or no change in perceived activation during the exercise bout, and that perceived activation would not be influenced by the cognitive variables measured.

Methods

Participants

Twenty-four low-active females with participated in this study. This group included all the participants from study two, plus four additional recruits.

Table 5.1. Descriptives for participants in study three.

Descriptives	Mean ±SD
Age (yrs)	23 ± 4.6
BMI	24.1 ± 3
VO2peak (ml.kg.min-1)	33.3 ± 5.5
VT (ml.kg.min-1)	18.2 ± 3.6
VT (as % of VO2peak)	54.7%

Measures

Affect. Affect was measured from the perspective of the circumplex model (Russell, 1980) using two independently validated single-item scales: the Feeling Scale (FS; Hardy & Rejeski, 1989), and the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985). See Chapter Three for full details of these scales.

Attentional Focus. Participants rated on a 10-point bipolar scale to what extent their thoughts were primarily associative or dissociative throughout the section of exercise just completed. See Chapter Three for full details of this scale.

Perceived Exertion. The Rating of Perceived Exertion scale (RPE; Borg, 1998) was used as a measure of whole-body ratings of perceived exertion during exercise. See Chapter Three for full details of this scale.

Self-Efficacy. Two measures of task self-efficacy were developed in accordance with Bandura's (1997) and McAuley and Mihalko's (1998) guidelines. Pre-exercise self-efficacy was measured by asking participants to rate, as a percentage, their confidence in their ability to cycle at a moderately fast pace for 10, 20, 30, 45 and 60 min without stopping. The internal consistency of this scale (cronbach's alpha) was .94 in the known duration condition and .92 in the unknown duration condition. Task self-efficacy was measured during exercise by asking participants to rate, as a percentage, their confidence in their ability to continue cycling at the current pace for 10, 30 and 60 min without stopping. The internal consistency of this scale (cronbach's alpha) was greater than .90 at all assessed time-points in both exercise sessions. Full details of these scales and their development can be found in Chapter Three.

Procedures

Participants engaged in two counterbalanced 30 min cycle ergometer exercise bouts, during which affective valence, perceived activation, perceived exertion, self-efficacy and attentional focus were assessed every 3 min. Self-efficacy, affective valence and perceived activation were also assessed before exercise (before protocol information was given), and measures of affect (i.e., affective valence and perceived activation) were taken every 5 min after both exercise bouts for 10 min. For one of the exercise conditions participants had full knowledge of the exercise duration (Known Duration; KD), in the other they had no knowledge of the exercise duration (Unknown Duration; UD) except that it would not exceed 60 min. The intensity was set at a workload equivalent to 90% of VT in order to ensure that participants began exercising within the 'moderate' intensity domain, and as time elapsed during exercise and more physiological demands were placed upon participants, it was expected that they would move towards VT and into the 'heavy' intensity domain. Intensity and duration of exercise were selected in order to reflect current daily physical activity recommendations. Full details of the procedures in this study (including how 90% VT was calculated) are provided in Chapter Three.

Results

The results are presented chronologically with respect to each hypothesis that was tested.

Intensity Manipulation Check

Condition (2) x Time (5) repeated-measures ANOVAs were conducted on both HR and RPE data to assess changes in intensity over time. Although data were collected every 3 min during exercise (i.e., nine time-points from min3 to min27), only data from every other time-point were entered into each ANOVA in order to reduce the number of repeated measures. As expected, results revealed that both HR ($F(4, 92) = 62.346$, $p < .001$, $\eta^2 = .73$) and RPE ($F(4, 88) = 22.937$, $p < .001$, $\eta^2 = .51$) increased significantly over time. Interestingly, however, there was a significant condition main effect ($F(4, 23) = 6.694$, $p < .05$, $\eta^2 = .23$) and a time x condition interaction that approached statistical significance ($F(4, 92) = 2.374$, $p = .058$, $\eta^2 = .09$) for RPE. Follow-up pairwise comparisons with Benjamini-Hochberg False Discovery Rate corrections (FDR; Benjamini & Hochberg, 1995) showed significant differences in RPE scores across all time-points in both conditions ($p < .05$) and significant differences between conditions at min21, min24 and min27 ($p < .05$).

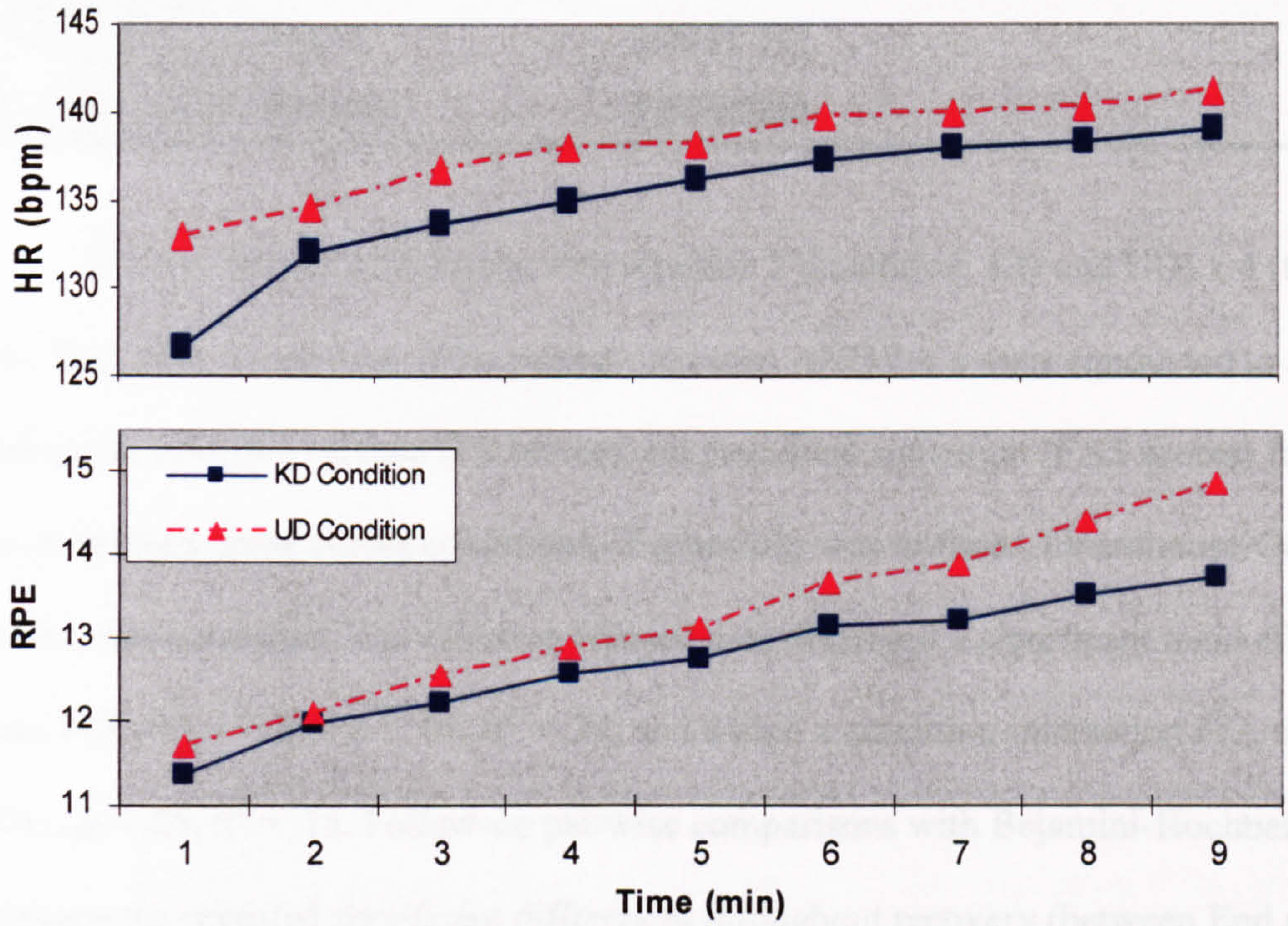


***Figure 5.1.* Heart Rate (HR) and Perceived Exertion (RPE) responses throughout 30 min of exercise at 90% VT, where the participant either had full knowledge of the exercise duration (KD = blue, solid line) or no knowledge of the exercise duration (UD = red, dashed line).**

These results revealed that perceptions of exertion increased throughout both exercise bouts, and were significantly higher towards the end of the exercise bout in the UD condition in comparison to the KD condition (figure 5.1). Whilst HR appeared to be higher throughout the UD compared to the KD condition, this observation was not supported by a statistically significant main effect for condition.

Hypothesis 1: Pre-post changes in affect

***Table 5.2.* Benjamini-Hochberg pairwise comparisons of pre- to post-exercise FS scores in the KD and UD conditions: Effect Sizes** (* p <.05; ** p <.01)

		Mean (SD)	End (30)	Post-0	Post-10
KD condition	Pre-Exercise	1.85 (2.17)	-.011	.16	.50*
	End (min30)	1.65 (1.34)		.37*	.83*
	Post-0	2.13 (1.30)			.46*
	Post-5	2.46 (1.18)			
	Post-10	2.71 (1.26)			
UD condition	Pre-Exercise	2.19 (1.71)	-.73*	-.21	.25
	End (min30)	.90 (1.89)		.56**	1.06**
	Post-0	1.85 (1.57)			.51**
	Post-5	2.29 (1.23)			
	Post-10	2.56 (1.26)			

For the first set of analyses, two separate 2 (condition; KD and UD) x 4 (time; pre-, End, post-0, and post-10) repeated-measures ANOVA's were conducted to assess changes in affective valence (FS scores) and perceived activation (FAS scores) from pre- to post-exercise across conditions. If sphericity was violated, Greenhouse-Geisser's epsilon was consulted. The affective valence data displayed a significant main effect for time, $F(3, 69) = 7.359, p < .01, \eta^2 = .24$, and a time x condition interaction $F(3, 69) = 4.041, p < .05, \eta^2 = .15$. Follow-up pairwise comparisons with Bejamini-Hochberg comparisons revealed significant differences throughout recovery (between End and post-0, End and post-10 and between post-0 and post-10) for both conditions ($p < .05$). Additionally, there was a significant difference between pre-exercise and End in the UD condition ($p < .05$). Consultation of Table 5.2 revealed that affective valence dropped significantly from pre-exercise to the end of exercise in the UD condition, but not in the KD condition. A significant increase in affective valence was also observed in both conditions immediately upon cessation of exercise that continued throughout recovery (i.e., 4 min cool-down and 10 min of rest).

Table 5.3. **Benjamini-Hochberg pairwise comparisons of pre- to post-exercise FAS scores collapsed across conditions: Effect Sizes** (* p <.05; ** p <.01)

	Mean (SD)	End (30)	Post-0	Post-10
Pre-Exercise	2.26 (0.90)	.68	.07	-.05
End (min30)	2.84 (0.85)		-.24	-.77**
Post-0	2.65 (0.78)			-.56*
Post-5	2.32 (0.90)			
Post-10	2.22 (0.80)			

There was also a significant main effect for time on the perceived activation data, $F(4, 68) = 5.603, p < .01, \eta^2 = .20$, but no condition main effect or condition x time interaction. Subsequently, results were collapsed across conditions and follow-up analyses were conducted with Benjamini-Hochberg corrections, which revealed significant differences between the End time-point and post-0, and between post-0 and post-10. Table 5.3 shows that these results were indicative of a significant decline in perceived activation from the end of the exercise bout throughout that cool-down and the 10 min post-exercise rest period.

Hypothesis 2: Between condition differences in affective responses during exercise

This set of analyses involved separate 2 (condition) x 5 (time) repeated measures ANOVA's on the FS and FAS data. Again, although data were collected every 3 min during exercise, only data from every other time-point were entered into each ANOVA. Results revealed a significant main effect for time, $F(4, 92) = 10.758$, $p < .01$, $\eta^2 = .32$; and time x condition interaction, $F(4, 92) = 5.011$, $p < .01$, $\eta^2 = .18$, for FS scores during exercise. There were no significant effects for perceived activation during exercise. Further analysis of the affective valence data using Benjamini-Hochberg pairwise comparisons showed that, in the KD condition, affective valence was significantly different between min3 and min15 ($p < .05$), and all subsequent time-points (p < .05), and between min6 and all subsequent time-points (p < .05). In this condition there were no significant changes from halfway through the exercise bout (min15) onwards. In contrast, analysis of the UD condition showed no significant changes early in the exercise bout, but significant differences were revealed between affective valence at min3 and min21 (p < .01) and between min3 and min27 (p < .01).

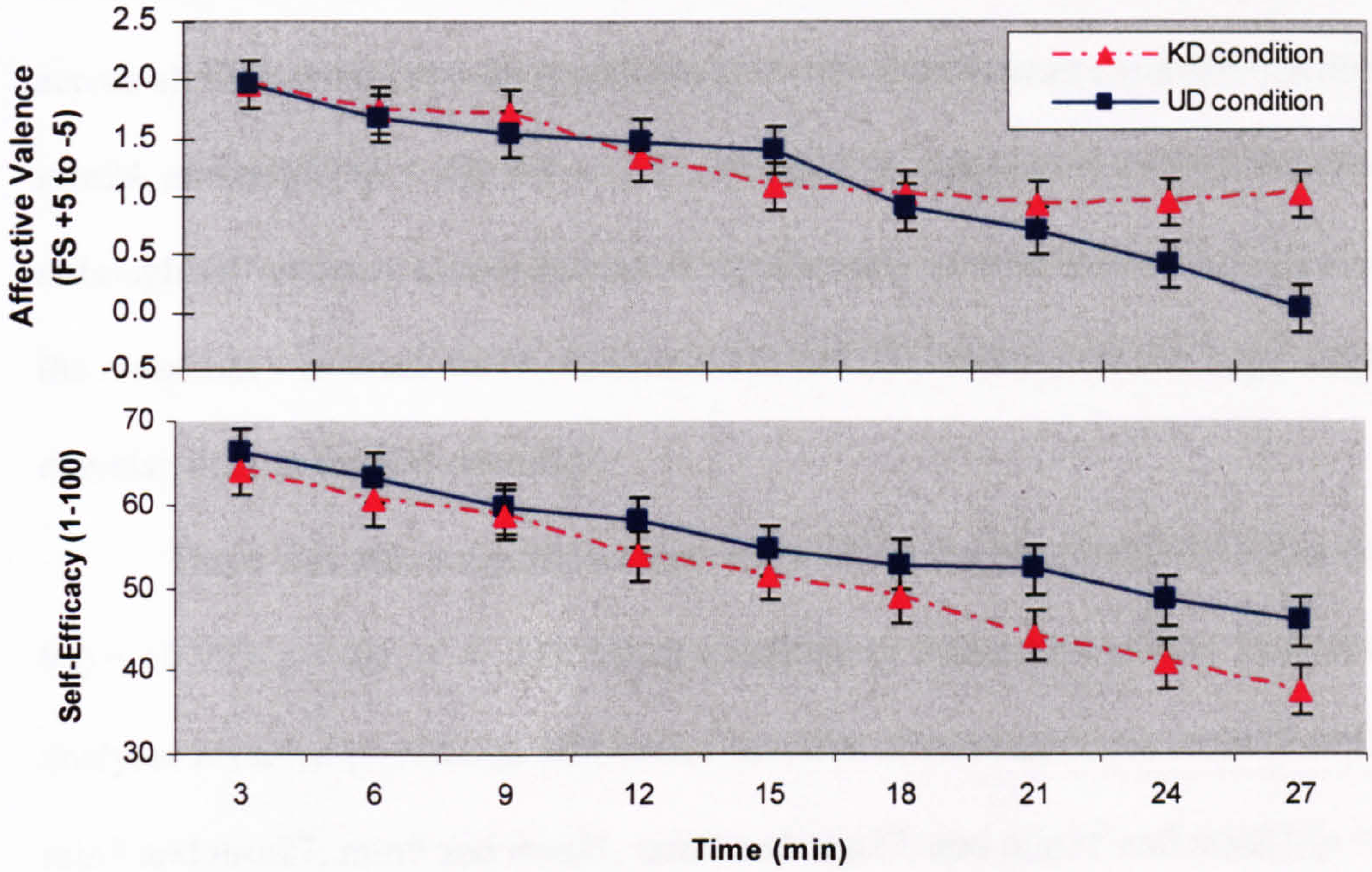


Figure 5.2. **Feeling Scale (FS) and Self-Efficacy responses throughout 30 min of exercise at 90% VT where the participant either had full knowledge of the exercise duration (KD = blue, solid line) or no knowledge of the exercise duration (UD = red, dashed line).**

There were also significant differences between affective valence at min9 and min21 (p < .05), min9 and min27 (p < .01) and between all subsequent adjacent time-points in the UD condition (p < .05 and p < .01). The only significant difference between conditions occurred at min27 (p < .05; ES=-.49), where affective valence was significantly lower in the UD condition compared to the KD condition. Details of this data can be found in Table 5.4, along with effect sizes for each comparison.

Hypothesis 2: Between condition differences in cognitive appraisal factors during exercise.

Consistent with analyses on the affect data, separate 2 (condition) x 5 (time) repeated measures ANOVA's were conducted on the self-efficacy and attentional focus during-exercise data. A significant time main effect ($F(4, 92) = 51.618$, $p < .001$, $\eta^2 = .69$) and a time x condition interaction ($F(4, 92) = 4.062$, $p < .05$, $\eta^2 = .15$) were evident for the self-efficacy data. Follow-up analyses revealed that significant changes occurred across all time-points in both conditions ($p < .05$) and between conditions at min21, min24, and min27 ($p < .05$; ES = -.37, -.33 and -.36, respectively). This indicates that, although self-efficacy scores decreased significantly as time elapsed in both conditions, the reduction was much more pronounced in the UD condition in the latter stages of exercise than in the KD condition.

There was also a significant time main effect for the attentional focus data (($F(4, 92) = 10.953$, $p < .01$, $\eta^2 = .32$), but no condition or interaction effects. Follow-up analyses revealed significant differences between attentional focus at min3 and min21, min3 and min27, min9 and min21, min9 and min27, and min15 and min27 ($p <.05$). These results indicate that participants reported predominantly dissociative thoughts at the beginning of exercise (min3 = 7.29; SD = 1.76), and that attentional focus became progressively more associative as time elapsed during both exercise bouts (min27 = 5.25; SD = 1.76). However, the extent to which attentional focus changes occurred during exercise did not differ as a function of knowledge of exercise duration.

Overall, these results indicate that attentional focus became progressively more associative and self-efficacy perceptions deteriorated throughout 30 min of exercise at 90% of VT. Attentional focus did not alter as a function of the participant's knowledge of elapsed time and the overall exercise duration. However, self efficacy perceptions differed towards the end of the exercise bout as a function of whether the participant

Table 5.4. **Pairwise comparisons of during-exercise FS, and self-efficacy scores across time in the KD and UD conditions: Effect Sizes (*** $p < .05$; ** $p < .01$).

		KD condition					UD condition				
	Time	**Mean (SD)**	**Min9**	**Min15**	**Min21**	**Min27**	**Mean (SD)**	**Min9**	**Min15**	**Min21**	**Min27**
Feeling Scale	Min3	1.96 (1.67)	-.18	-.68*	-.61*	-.58*	1.96 (1.52)	-.28	-.34	-.78**	-.98**
	Min6†	1.73 (1.38)					1.67 (1.34)				
	Min9	1.71 (1.08)		-.51**	-.55*	-.51*	1.54 (1.50)		-.09	-.52*	-.77**
	Min12†	1.33 (1.27)					1.48 (1.74)				
	Min15	1.08 (1.27)			-.09	-.04	1.40 (1.79)			-.40*	-.66**
	Min18†	1.02 (1.42)					.92 (1.98)				
	Min21	.94 (1.72)				.05	.71 (1.76)				-.33*
	Min24†	.96 (1.61)					.42 (2.12)				
	Min27	1.02 (1.62)					.04 (2.39)				
Self-Efficacy	Min3	66.18 (14.02)	-.58*	-.82*	-.92*	-1.30**	64.03 (17.86)	-.29*	-.69*	-.95**	-1.19**
	Min6†	63.19 (15.57)					60.55 (18.18)				
	Min9	59.49 (16.54)		-.28*	-.39*	-.75**	58.68 (19.44)		-.36*	-.67*	-.92**
	Min12†	57.89 (17.93)					53.82 (20.23)				
	Min15	54.45 (19.60)			-.11*	-.43*	51.45 (21.04)			-.32*	-.59*
	Min18†	52.71 (19.78)					48.74 (24.19)				
	Min21	52.30 (20.50)				-.32*	44.30 (24.26)				-.27*
	Min24†	48.56 (19.81)					40.93 (26.28)				
	Min27	45.98 (20.22)					37.64 (26.72)				

had knowledge of elapsed time and overall exercise duration, an observation that was in concordance with affective valence findings.

Hypothesis 4: Do cognitive appraisal factors during 'moderate'-'heavy' intensity exercise account for any variance in during-exercise affective valence?

Due to the fact that there were no condition-based differences in attentional focus, further analysis of these data was unwarranted. However, further analysis of the relationship between self-efficacy and affective valence is clearly warranted, given that,

(a) Cognitive appraisal factors are thought to account for variation in affective valence at work rates that approximate the VT (Ekkekakis, 2003; Ekkekakis et al., 2005a),

(b) There was a similar time x condition interaction for both affective valence and self-efficacy responses during exercise, manifested by pronounced between-condition differences in these variables during the second half of exercise, and

(c) Significant between condition differences in self-efficacy perceptions occurred slightly earlier than condition differences in affective valence during exercise, which indicates support for the theoretical perspective that variation in self-efficacy precedes variation in affective valence (Ekkekakis et al., 2005a).

Data Reduction

The initial hypothesis included the suggestion that self-efficacy during exercise would be a stronger predictor of variation in affective valence than pre-exercise self-efficacy would. However, time x condition pairwise comparisons indicated that there may have been a different relationship between self-efficacy and affect during the first part of the exercise in comparison to the end of exercise (see Table 5.4 and Figure 5.2). Therefore, in order to assess whether pre-exercise and/or during-exercise self-efficacy perceptions accounted for variance in affective valence, and whether this relationship was affected by time during exercise, a series of four hierarchical regression analyses were conducted. That is, two separate hierarchical regression models were designed to investigate the relationship between self-efficacy and affect halfway through each exercise bout (KD and UD), and the other two hierarchical regression models were designed to investigate the relationship between self-efficacy and affect during the final minutes of each exercise bout (KD and UD).

For each of the first two models, the average FS score during the middle of the exercise bout was calculated (FS at min12 + FS at min15 ÷ 2) as the dependent variable. Then the average self-efficacy score during the few min immediately preceding this was calculated (self-efficacy at min6 + self-efficacy at min9 ÷ 2) as the during-exercise self-efficacy independent variable. These time-points were chosen because min12-15 was approximately halfway through the exercise bout and by this point participants would have obtained sufficient exercise experience to draw upon when responding to the self-efficacy scale, differentiating it substantially from pre-exercise expectations, appraisals, and experiences.

For each of the second two models, the average FS score during the last few min of exercise was calculated (FS at min24 + FS at min27 ÷ 2) as the dependent variable. Then the average self-efficacy score during the min immediately preceding this was calculated (self-efficacy at min18 + self-efficacy at min21 ÷ 2) as the during-exercise self-efficacy independent variable. Rather than select single time points, the averages of two time points were calculated in order to enhance measurement reliability of the variables.

Data Analysis

Predictor	Beta	R^2	R^2_{change}	F_{change}	P
Known Duration condition – Dependant Variable: Average FS for min12-15					
1. Age	.352				
BMI	.185				
$\dot{V}O_2$peak	.344				
Pre-exercise FS	.168	.196	.196	1.157	.360
2. Age	.363				
BMI	.190				
$\dot{V}O_2$peak	.354				
Pre-exercise FS	.168				
Pre-exercise SE	.040	.197	.002	.034	.856
3. Age	.350				
BMI	.138				
$\dot{V}O_2$peak	.285				
Pre-exercise FS	.134				
Pre-exercise SE	-.154				
Average SE for min6-9	.313	.257	.060	1.368	.258
Total R^2 = .26, $F(6,23)$ = .981, p = .468					
Unknown Duration condition – Dependant Variable: Average FS for min12-15					
1. Age	.287				
BMI	-.169				
$\dot{V}O_2$peak	-.049				
Pre-exercise FS	.361	.247	.247	1.562	.225
2. Age	.302				
BMI	-.111				
$\dot{V}O_2$peak	-.063				
Pre-exercise FS	.287				
Pre-exercise SE	.147	.262	.015	.355	.558
3. Age	.351				
BMI	-.045				
$\dot{V}O_2$peak	-.019				
Pre-exercise FS	.238				
Pre-exercise SE	-.449				
Average SE for min6-9	.771	.470	.208	6.652	.020*
Total R^2 = .47, $F(6,23)$ = 2.508, p = .063					

Table 5.5. **Hierarchical regression models detailing the influence of Self-Efficacy (SE) on affective valence (FS) during the first half of two 30 min exercise bouts at 90% VT, whilst controlling for age, BMI, fitness ($\dot{V}O_2$peak) and pre-exercise affective valence.**

After controlling for age (from 18 to 35 years), body mass index (from 18.5 to 30.5 kg/m^{-2}), fitness ($\dot{V}O_2$peak from 23.17 to 43.45 ml.kg.min^{-1}) and pre-exercise affective valence (FS scores from -2 to 5) in step 1 of all four models, self-efficacy scores were entered into subsequent steps of each model to assess their impact on the dependent variable (i.e., affective valence). Therefore, to assess the relationship between self-efficacy and affective valence halfway through the KD exercise bout (dependent variable = average FS for min12-15 of KD), pre-exercise self-efficacy was entered into step 2, and average self-efficacy for min6-9 was entered into step 3. This analysis was then performed on the UD data. To assess the impact of self-efficacy upon variance in affect at the end of the KD exercise bout (dependent variable = average FS for min24-27 of KD), pre-exercise self-efficacy was entered into step 2, and average self-efficacy for min18-21 was entered into step 3. Exactly the same analytic approach was performed on the UD data.

Predictor	Beta	R^2	R^2_{change}	F_{change}	P
Known Duration condition – Dependant Variable: Average FS for min24-27					
1. Age	.374				
BMI	-.076				
$\dot{V}O_2$peak	.106				
Pre-exercise FS	.039	.159	.159	.899	.225
2. Age	.433				
BMI	-.045				
$\dot{V}O_2$peak	.163				
Pre-exercise FS	.042				
Pre-exercise SE	.232	.209	.050	1.130	.558
3. Age	.410				
BMI	-.153				
$\dot{V}O_2$peak	-.081				
Pre-exercise FS	.037				
Pre-exercise SE	.000				
Average SE for min18-21	.481	.359	.150	3.993	.062
Total R^2 = .36, F(6,23) = 1.589, p = .211					
Unknown Duration condition – Dependant Variable: Average FS for min24-27					
1. Age	.255				
BMI	-.061				
$\dot{V}O_2$peak	.254				
Pre-exercise FS	.279	.219	.219	1.333	.294
2. Age	.302				
BMI	.120				
$\dot{V}O_2$peak	.209				
Pre-exercise FS	.049				
Pre-exercise SE	.457	.359	.140	3.944	.062
3. Age	.254				
BMI	.050				
$\dot{V}O_2$peak	.109				
Pre-exercise FS	.084				
Pre-exercise SE	-.214				
Average SE for min18-21	.866	.652	.293	14.299	.001**
Total R^2 = .65, F(6,23) = 5.310, p = .003					

Table 5.6. **Hierarchical regression models detailing the influence of Self-Efficacy (SE) on affective valence (FS) during the final stages of two 30 min exercise bouts at 90% VT, whilst controlling for age, BMI, fitness ($\dot{V}$O2peak) and pre-exercise affective valence.**

Results indicated that when knowledge of the exercise duration was known (i.e., KD condition), self-efficacy did not account for any significant variance in affect during the middle of the exercise bout. However, average self-efficacy during min18-21 accounted for 15% of variance in affect at the end of the KD exercise bout ($p = .062$)[4]. When exercise duration was unknown (i.e., UD condition), self-efficacy perceptions during-exercise predicted 21% of the variance in affect during the first half of the exercise bout ($p < .05$), and both pre-exercise self-efficacy and during-exercise self-efficacy predicted a substantial amount of the variance in affect at the end of the UD exercise bout (14%; $p = .062$ and 29%; $p < .01$, respectively).

Discussion

The primary objective of this investigation was to assess the notion that cognitive appraisal factors play a significant role in governing the affective responses of low-active women during exercise at an intensity that approximated VT. In order to achieve this objective, participants exercised for 30 min (plus warm-up and cool-down) under two conditions: one in which they had full knowledge of the exercise duration (KD) and one in which exercise duration was unknown (UD). Affect, self-efficacy, and attentional focus responses were measured throughout both exercise bouts in order to assess whether affect and cognitive appraisal factors varied in response to the manipulation of participants' perceptions of exercise duration, and whether these cognitive appraisal factors accounted for variance in during-exercise affective responses.

Intensity manipulation check

Both heart rate and perceived exertion increased as time elapsed during exercise. Due to the linear relationship between heart rate and oxygen consumption (Wasserman, Hansen, Sue, Stringer & Whipp, 2004), this observation indicates that intensity increased above 90% VT as exercise progressed. From a physiological perspective this

[4] Although the α level was set at .05 in the present study, the decision was made to treat the results (detailed in Tables 5.5 and 5.6) where $p = .062$ as significant, given the relatively small sample size and the subsequent probability that these were the result of Type II error.

was to be expected and, given the size of the increase in these values, it is likely that by the end of the exercise bout participants were working at, if not above, VT.

Interestingly, perceptions of exertion were significantly higher throughout the UD condition in comparison to KD, which was in contrast to Baden et al.'s (2005) findings that perceived exertion did not differ significantly between known and unknown duration treadmill conditions. However, the participants in Baden et al.'s (2005) study were all highly fit, experienced runners and also reported *reduced* physiological strain (measured by oxygen consumption) during the exercise bout of unknown duration. Those results were attributed to improvements in running economy via the use of a 'pacing' strategy when exercise duration was unknown, a strategy that is argued to be influenced by experience of the task (which participants in the present study did not have; St Clair Gibson et al., 2006). Unfortunately, oxygen consumption was not measured during the present study so direct comparisons to this aspect of Baden at al.'s study can not be made. Nonetheless, this may be worth investigating in future research with inexperienced exercisers, considering that elevated perceptions of exertion (a psycho*physiological* construct; Borg, 1998) were observed during the UD condition in the present study.

Pre-post changes in affect

From pre- to immediately post-exercise (i.e., the End time point) a significant decline in affective valence was observed in the UD condition. This response was likely to be due to the more negative valence reported during the final stages of this exercise bout compared to the KD condition. By the end of the cool-down, affective valence (FS scores) had returned to baseline levels, and then proceeded to rise continuously throughout the 10-min recovery period in both conditions. However, at 10-min post-exercise, affective valence was significantly higher compared to baseline in the KD condition. Upon inspection of the mean scores it becomes apparent that this seeming discrepancy between conditions is likely to be due to the higher pre-exercise affective valence reported in the UD condition compared to the KD condition, and there was no significant difference between conditions at post-10. As anticipated, although perceived activation levels did rise significantly from pre- to post-exercise, this increase was temporary and activation levels returned to baseline by 10 min after the cool-down.

Between condition differences in affect, self-efficacy and attentional focus responses during exercise.

During-exercise affect results showed that there was no change in perceived activation during either of the conditions, in contrast to affective valence, which began to decline in a similar fashion in the early stages of both exercise bouts. However, whilst affective valence deteriorated significantly from the beginning to the end of exercise in both conditions, this deterioration was much greater overall when exercise duration was unknown (see Table 5.4 for effect sizes). Figure 5.2 illustrates that in the KD condition affective valence reached a plateau approximately halfway through the exercise and remained at that level until the exercise bout was over. In contrast, affective valence continued its decline throughout the UD condition. This evidence, that affective valence responses during 'moderate'-'heavy' intensity exercise were susceptible to perceptual manipulation, provides support for the notion that affective valence is governed by cognitive appraisal factors (cf. the dual-mode model, Ekkekakis, 2003, Ekkekakis et al., 2005a). During-exercise self-efficacy responses displayed similar patterns, in that they differed significantly between conditions towards the end of the exercise bout. This indicates that self-efficacy perceptions can vary throughout an exercise task and as a function of the task, which is unsurprising given Bandura's (1997) contention that uncertainty about one's capabilities and about the requirements of the task itself can have a significant negative impact upon an individual's efficacy.

Based upon St Clair Gibson et al.'s (2006) theorising, it also seems plausible to suggest that individuals with limited previous experience of exercise and the associated internal sensations would be hindered in their ability to employ teleoanticipatory processes. Their proposal that previous experience and cognitive appraisal of internal and external stimuli play a role in pacing strategies could provide some explanation for the higher RPE, lower self-efficacy and lower affective responses observed towards the end of the UD exercise bout within this low-active sample. Indeed, the importance of experience in teleoanticipation could also serve to explain why perceptions of exertion were elevated and affect declined as both exercise bouts progressed, and why similar results were not observed by Baden et al. (2005) with a sample of experienced runners.

Contrary to hypothesis 3, attentional focus did not differ as a result of perceptual manipulation. This observation is consistent with previous research that used a similar measurement scale and found attentional focus to become progressively more associative as the exercise bout progressed, irrespective of whether they had knowledge of the exercise duration (Baden et al., 2005). However, the present results should be interpreted with caution because of limitations in the method employed to measure attentional focus. Merely asking participants whether their thoughts are more associative or dissociative gives no indication as to whether these thoughts are perceived as facilitative or debilitative. For example, one participant could focus internally upon breathing patterns to help pace herself, whereas another participant could find that focusing on her breathing increases personal awareness of physiological strain. Other researchers (e.g., Stevinson & Biddle, 1998; Masters & Ogles, 1998) have also pointed out that basic dichotomies are too simplistic to account for the full complex spectrum of runner's cognitions, and multidimensional measures of attentional focus have been adopted in exercise studies in recent years (e.g., LaCaille, Masters & Heath, 2004; Stevinson & Biddle, 1998). Future research into attentional focus tendencies amongst inexperienced exercisers should take into consideration the value attributed to associative or dissociative thoughts.

Pre- and during-exercise self-efficacy as predictors of during-exercise affective valence.

The similarity between self-efficacy and affective response patterns suggests that self-efficacy during-exercise may play an important role in governing changes in affective responses during exercise at VT. In order to explore the notion that self-efficacy perceptions could explain variance in valence responses during exercise, four separate hierarchical regression analyses were conducted. Findings showed that self-efficacy manifested *pre*-exercise explained some variance in affect only at the end of the UD condition ($R^2 = .14$), and not half-way through either exercise bout. Likewise, self-efficacy perceptions manifested *during*-exercise did not account for significant variance in affect halfway through exercise when exercise duration was known. However, during-exercise self-efficacy was a significant predictor of mid-exercise affective variance when duration was unknown ($R^2 = .21$), and in both conditions towards the end of exercise (KD $R^2 = .15$; UD $R^2 = .29$). In summary, results of the hierarchical regression models depicted in Tables 5.5 and 5.6 indicated that self-efficacy perceptions appeared to play an important role in governing affect when the exercise was most challenging (i.e., towards the end of exercise and when exercise duration was unknown). Indeed, the combination of self-efficacy perceptions manifested both pre- and during-exercise accounted for a total of 43% of the variance in affect reported at the end of the UD condition.

The present results demonstrate that self-efficacy perceptions that occur during an exercise bout are generally a much stronger predictor of affective responses than those expectations held before the exercise bout. As no previous research has measured self-efficacy repeatedly during exercise, there is little evidence to compare these results to. However, recall that McAuley and Courneya (1992) and Tate et al. (1995) reported that pre-exercise self-efficacy explained only 3% and 6%, respectively, of variance in during-exercise affect. Arguably, based upon results of the present study, they would have observed stronger relationships between the constructs had self-efficacy been measured during exercise. Therefore, whilst these results support Bandura's (1986, 1997) contention that efficacy expectations antedate affect, they strongly suggest that relationship between the two constructs is strongest during exercise, when the individual has immediate experience to draw upon.

Another important observation was that the relationship between self-efficacy and affect was stronger towards the end of both exercise bouts when compared to the mid-point during exercise. This has important theoretical implications with respect to the propositions of Ekkekakis' (2003, Ekkekakis et al., 2005a) dual-mode model. To recap, this model suggests that cognitive factors, such as self-efficacy perceptions, have a low to moderate influence on affective responses during exercise at intensities below VT, but have a much stronger influence on affective responses to exercise at and just above this threshold. This theory finds support in the present results given that the exercise bout in this study was set at a workload that equated to 90% of VT, and that increases in heart rate and perceptions of exertion during exercise were indicative of intensity progression to and possibly beyond the VT by the end of exercise. Thus, the discovery that the relationship between self-efficacy and affect was stronger at the end than halfway through both exercise bouts can be explained by the change in exercise intensity as time elapsed.

However, it must be noted that the strength of the self-efficacy/affect relationship was evidentially not solely intensity-dependent. Self-efficacy perceptions accounted for only 15% of variance in end-of-exercise affect when exercise duration was known, yet when participants were presented with the additional perceptual challenge of unknown exercise duration, self-efficacy perceptions accounted for a much greater amount of variance in affective valence (i.e., 29%; nearly double). In order to explain this finding it is worth re-exploring the observation that perceptions of exertion were significantly higher throughout the UD condition in comparison to KD. This discovery was initially surprising as the results were in contrast to Baden et al.'s (2005) study (with a sample of highly fit, experienced runners), during which perceived exertion did not differ significantly between known and unknown duration treadmill conditions. There was also no difference in affective valence between known and unknown duration conditions in Baden et al.'s (2005) study, which was also in contrast to the present study. It is possible that the elevated perceptions of exertion amongst the inexperienced exercisers in the UD condition were mediated by participants' perceptions of capability (i.e., self-efficacy perceptions), and therefore contributed indirectly to their affective experience of the exercise bout. This interpretation finds support in self-efficacy theory, which states that "whether effort attributions carry positive or negative connotations depends on their conceptions of ability" (Bandura, 1997, p. 225). Thus, considering the particularly low self-efficacy perceptions towards the end of the UD condition (in comparison to the KD condition) in the present study, it is possible that increased perceptions of exertion may have carried increased negative connotations. Based upon the findings of the present study, the nature of the relationship between perceptions of exertion, affect and self-efficacy during exercise clearly warrants further investigation.

Conclusions

Overall, these results suggest that cognitive appraisal of the task influenced affective responses of low-active women during an acute bout of exercise at the approximate point of VT. The implications of these observations are considerable from both theoretical and practical perspectives. From a theoretical perspective, these results first and foremost contradict a long-held belief among exercise psychologists that exercise intensities in the 'moderate' domain (e.g., around 60% $\dot{V}O_2$max, which would have been above VT for most of the women in this study) are likely to induce positive affective responses (Raglin & Morgan, 1985). Clearly, what one thinks about and how one appraises a task significantly impacts upon affect during exercise at 'moderate' intensities. The results provide strong support for the recently conceived dual-mode model (Ekkekakis, 2003), which suggests that the mechanisms underlying affective responses during exercise in the moderate-heavy intensity domain are predominantly cognitive, and affective valence is likely to vary as a function of cognitive appraisal of the task.

From a practical perspective, the observation that affect declined during exercise is of particular importance when we consider that the low-active females in this study performed the recommended daily exercise dose (30 min at 'moderate' intensity). This observation is particularly concerning with respect to the theory that people seek out all pleasant stimuli and try to avoid all unpleasant stimuli (Cabanac, 1971; 1992). On a more positive note, these results suggest that although affective responses of inexperienced female exercisers may decline during exercise, they are likely to feel more positive post-exercise than they did beforehand. With this in mind, the next obvious question to be answered by researchers is clearly whether affective responses that occur during exercise are more likely to drive future behaviour than those experienced once the exercise is over (as suggested by research in other areas of health psychology; e.g., Redelmeier & Kahneman, 1996) or vice versa.

Another important finding of this research was changes in affect that occur during exercise can be explained to a relatively large extent by appraisal of the task and an individual's perceptions of self-efficacy. Self-efficacy perceptions are likely to improve with performance accomplishments (Bandura, 1997). With repeated performances ones level of uncertainty will probably be reduced (as she gets a better idea of what she can and can't do), which is an important frame of reference for a obtaining a sense of mastery (Bandura, 1997). Also, evidence suggests that self-efficacy perceptions in relation to an exercise task are susceptible to manipulation, which can positively impact upon affective responses (McAuley et al., 1999; Jerome et al., 2002). With these points in mind, practitioners should be urged to focus on creating an environment and exercise task that is unlikely to be perceived as aversive to inexperienced exercisers. Practitioners are also encouraged to explore cognitive strategies of inducing or maintaining positive task self-efficacy perceptions that inexperienced exercisers can employ *during* the exercise bout. Since self-efficacy is effectively governed by perceptions of control, this may be achieved by employing very simple strategies that increase the perception of control one has over the task at hand. For example, based upon the present result it can be suggested that ensuring that as many aspects of the exercise situation as possible are unambiguous will reduce the negative impact of low self-efficacy beliefs upon affective valence. These strategies will be most important in the individual's first few exercise sessions, where self-efficacy is likely to be lowest. Given the results of the present study, the application of these kinds of strategies could have a substantial impact on people's experience of exercise during the adoption phase of an exercise programme.

Chapter Six: Study Four

Reflections on the exercise experience: An exploratory mixed-methods investigation into the affect-perception-cognition interaction during acute exercise.

Introduction

The dual-mode model (Ekkekakis, 2003) represents an important theoretical advancement within the field of exercise psychology as it proposes a systematic relationship between exercise intensity and affective responses during exercise. This model advocates that affective responses during exercise are the result of the interplay between two influences, namely cognitive appraisals and physiological cues. Specifically, the ratio of their influence is theorised to change across exercise intensities, whereby cognitions effectively dominate until they are over-ridden by interoceptive cues that are associated with increased physical demands upon the body. The model suggests (Ekkekakis et al., 2005a) that there is a low to moderate influence of cognitive factors during exercise below the ventilatory threshold (VT[5]), and most people's affective responses remain primarily positive at this intensity. When exercise intensity becomes more challenging (i.e., exceeds VT), more variability in affective valence is theorised to be the result of the strong influence of cognitive appraisal factors. The influence of cognitive appraisal becomes overridden by physiological (interoceptive) cues when the intensity becomes too demanding for the body to maintain a steady state (i.e., above the ventilatory threshold at the level of critical power[6]) and, accordingly, affective responses deteriorate. Ekkekakis and Petruzzello (2002) also suggested that, "at the present stage of knowledge development, measurement in descriptive studies should focus primarily on basic affect" (p. 36), thereby advocating

[5] Ventilatory Threshold = the point at which there is no sustained increase in blood [lactate] or decrease in arterial blood pH (Whipp & Özyener, 1998)

[6] Critical Power = the highest work rate at which blood lactate and $\dot{V}O_2$ can be maintained in a steady state (Poole, Ward, Gardner & Whipp, 1988)

the use of the circumplex model as a framework for research in exercise psychology, as "its strength lies mainly in its parsimony, not its specificity" (p.35).

In keeping with this standpoint, studies two and three employed experimental manipulation and simple quantitative measurement tools to investigate the principles of the dual-model model (Ekkekakis, 2003; Ekkekakis et al., 2005a) within a low-active female sample, and explored in detail the unique perceptual and cognitive changes that occurred throughout 30 minutes of exercise just below VT. The simplicity of the measures employed was fundamental to the functionality of these investigations, due largely to the ease of their use repeatedly during exercise. As a result, we are left with a clear, simple depiction of low-active female's affective responses during and after exercise. It was observed in study two that during an incremental exercise test (IET), a mean progressive decline in affective valence began below VT and continued until volitional exhaustion, and that this decline corresponded with progressively more associative thoughts. In study three it was demonstrated that both affective and self-efficacy responses during moderate intensity exercise differed depending upon appraisal of the task.

However, a number of unanswered questions about the specific nature of the relationship between acute exercise, self-efficacy and affect remain, arguably due to the nature of the measurement tools employed. For example, we know that despite the sample being matched for gender and current activity level, a substantial amount of interindividual variation in both the direction and magnitude of affective changes was evident at various intensities in study two. It was also observed that thoughts were more dissociative at the beginning and more associative towards the end of exercise in both studies, yet it is unknown what these thoughts were, and whether the perception of these thoughts as facilitative or debilitative influenced the variance in affective change. Whilst reductions in self-efficacy occurred during the 30-minute exercise bouts in study three, what were the sources of these declines in efficacy? Were the participants conscious of these changes and the impact they had upon affect, and did any other types of self-reflection take place? Additionally, affective valence declined as exercise progressed and activation levels remained low during the exercise bouts in study three, but what specific emotions were manifested (if any)? Could these emotions be characterised by 'sadness', 'boredom', 'tiredness' (in line with circumplex theory); were there other or even a combination of emotions in existence? That said, can inexperienced exercisers even identify specific emotional responses to exercise, or were the feelings experienced just general feelings of displeasure (i.e., core affect)? In short, the reliance on deductive methods in these studies may have resulted in the loss of some of the richness and individuality of participants' experiences. This perspective is reinforced by researchers who have argued that the lack of consensus on the mechanism(s) by which exercise affects mental health and well-being may be because researchers have concentrated on establishing relationships between constructs, rather than reflecting on the varied experiences and personal 'meanings' ascribed by participants to those experiences (Crone, Smith & Gough, 2005; Fox, 2000).

Whilst parsimony was perceived as a strength of the measurement tools used in studies two and three as they enabled the first step to be taken (cf. Ekkekakis & Petruzzello, 2002), in order to further test the complexity of the relationship between cognitions and affect during exercise it is now necessary to take a step towards specificity. However, the quantitative measurement tools currently available (many of which lack adequate theoretical foundation; see Ekkekakis & Petruzzello, 2002) would not enable detailed investigation of questions about specific characteristics of the affect-perception-cognition interaction during exercise (such as those questions considered in the previous paragraph). Yet these questions are important ones to address if full investigation of interindividual variability in the exercise experience of low-active females is to be achieved. In order to overcome the restrictions of the post-positivist method, Crone et al. (2005) argued in favour of investigating the 'whole experience' of people participating in exercise from a psycho-physiological standpoint.

In support of this approach, one solution is to use a mixed quantitative/qualitative methodology to provide a holistic view of the exercise experience. This approach would enable the provision of quantitative psychological and physiological data alongside documentation of the experience in the participants' own words. Although 'alternative' forms of enquiry in sport and exercise psychology have received substantial support recently (Biddle, Markland, Gilbourne, Chatzisarantis, & Sparkes, 2001; Dale, 1996), there appears to have been little qualitative, exploratory investigation into the physical activity experiences of inexperienced adult exercisers, and the scant research that does appear in the literature is mainly based upon chronic exercise experiences (e.g., Crone et al., 2005). Arguably, the field of *sport* psychology has been more forthcoming in adopting qualitative methods of enquiry than the field of *exercise* psychology. This is somewhat surprising given the potential for the generation of new hypotheses that these alternative methodologies can initiate, and the importance of inexperienced exercisers' unique experiences of acute exercise.

Interviews were therefore employed in the present study in order to bridge this gap in the literature, and to explore the complex relationship between affective, perceptual and cognitive responses to acute exercise. One of the strengths of in-depth interviewing is that we can come to understand the details of people's experience from their point of view (Seidman, 1991). Thus, the freedom allowed by this approach meant that participants were at liberty to expand upon their own thoughts, feelings, perceptions and explanations for their experiences in a process of self-reflection. As Dale (1996) commented, "not only does dialogue allow the person being interviewed the opportunity to describe experience, it also requires him or her to clarify its meaning and, perhaps, even realise it for the first time." (p. 310). This reflective process is arguably part of an internal dialogue that takes place within anyone participating in a new or unfamiliar experience (such as an exerciser during the adoption phase of an exercise programme), and may be somewhat responsible for one's decisions about whether to undertake that behaviour in the future. In this respect, what an individual recalls about the experience could be just as, if not more, important than what that individual reported as experiencing at the time. The purpose of this investigation was, therefore, to record this reflective process in order to create narrative profiles that give a voice to those individuals referred to as 'low-active females' throughout this thesis; those whose voices are often silenced in 'traditional' scientific research (Sparkes, 2002). These profiles were crafted to explore in detail the range and individual variability of the cognitive and perceptual processes underlying the affective exercise experience by utilizing both qualitative and quantitative data.

Methods

Participants

Six of the low-active female participants who completed the series of experiments described in Chapter Three volunteered for this study. The possibility that they may be asked to participate in two interviews (one after session two and one after the fourth session) was detailed in the informed consent form signed in session one (see Chapter Three for details). Participants were specifically (rather than randomly) selected for interview in order to fully explore *variability* in the affective exercise experience. For this reason, each person that was asked to participate was chosen because their affective responses to the maximal incremental exercise test (IET) in session 2 fulfilled one of the following three criteria, which were thought to capture the range of possible responses to the IET:

a) Affective Valence (i.e., FS scores) declined during the early stages of the IET.

b) Affective Valence declined in the latter stages of the IET.

c) Affective Valence remained positive throughout the IET.

Those that fulfilled the criteria outlined above were identified as soon as participants had completed the IET during session 2. Upon completion of the 20-min recovery phase participants were asked if they would be willing to be interviewed about their experience. It is important to note that it was not possible to identify whether participants' affective declines occurred before or after the VT until after analysis of the physiological data (which was not possible until session two was completed). Therefore, the criteria outlined in points a) and b) were formulated in an attempt to capture, a) a decline in affective valence before or at VT, and b) a decline in affective valence after the VT. The original intention was that at least nine participants (i.e., three that fulfilled each criterion) would agree to being interviewed. However, time-commitments prevented a number of potential candidates from being able to stay for the interview. In addition, only two of the full sample of 24 participants met the third criterion (c). As a result, a total of six participants (two that fulfilled each criterion) were recruited.

The Interviews

Participants completed two interviews: one took place after they had completed the IET during session 2 and the second took place at the end of the fourth session. These interviews were semi-structured and were designed to enable participants to explore their cognitive, affective and perceptual responses to the acute exercise bouts they had completed as part of their involvement in the study. Interview One took place immediately after the 20-min recovery phase during session two and explored participants perceptions of the experience as the intensity increased until volitional exhaustion was reached, and into recovery. Participants were asked to elaborate on thoughts and feelings throughout and after the exercise bout. They were also shown and asked to comment upon a graphical depiction of their affective responses plotted in a circumplex (e.g., see Figure 6.1). Interview Two took place after participants had completed all four sessions and full details about the exercise bouts were revealed (i.e., that the last two did not differ in their intensity or duration). Specifically, questions were designed to investigate whether participants' experience of the known duration (KD) and unknown duration (UD) conditions differed, and if so in what way. They were encouraged to explore their own perceptions of why their experiences may have differed. In addition, participants were asked about their previous experiences of physical activity and their general attitude towards physical activity in order to gain an insight into if and/or how they felt that these experiences related to the acute exercise experience.

In general, the first interview was shorter than the second and each interview lasted anywhere between approximately 15 and 45 minutes. A copy of the interview guide can be found in Appendix 9. Interviews were transcribed upon completion of each participant's involvement in the study and sent to participants to check that the transcription was an accurate representation of the interview.

Analysis of the interviews

Although there is no 'right' way to share interview data (Seidman, 1991), making 'thematic connections' is the most commonly employed and conventional method. However, the creation of 'profiles' (sometimes termed 'vignettes') to represent the interview data in the present study was chosen over other methods of analysis for the following reason. Congruent with Belgrave, Zablotsky, Guadagno's (2002) suggestions, it was deemed essential to employ a methodological strategy that was closely tied to the research goal. There was a concern that making thematic deductions from the present interviews would have resulted in the loss of idiosyncratic information that made each exercise experience unique. A profile is essentially a narrative investigation that carries with it an interpretation of the person, experience or situation that the narrator describes, much in the same way that anecdotes do (Ely, Vinz, Anzul, & Downing, 1997). Thereby, a profile in the words of the participant is arguably the research product that was most consistent with the process of interviewing (Seidman, 1991) and the research goal. Seidman's (1991) guidelines on working with interview material and creating vignettes were closely followed when constructing the profiles in the present investigation.

Initial exploration of the transcripts revealed that each participant elaborated on different aspects of the exercise experience. This was unsurprising given that Seidman (1991) had noted, "that only about one out of three interviews is complete and compelling enough to be shaped into a profile that has a beginning, a middle, and an end, as well as some sense of conflict and resolution." (p. 91). Close inspection of the transcripts also indicated that, of the six participants chosen for interview, three reported a preference for the KD condition over the UD condition and the other 3 reported the reverse. Therefore, rather than create profiles that portrayed each of the 6 individual experiences (which may have fallen short of depicting a *detailed* illustration of the experience), the decision was made to amalgamate the interviews to create 'semi-fictional' first-person profiles. These profiles have been described as 'semi-fictional' because they are both fictional (in the sense that a fictional individual has been created to tell each 'story'), and non-fictional (in the sense that the words used to tell each 'story' are those of actual lived experiences).

The researcher as an instrument in data collection and interpretation

It is important to pay heed to the role the researcher played in the creation of these narrative profiles, from influencing the interview process to interpreting and amalgamating individual experiences to create the representative narrative profiles. When one adopts this approach to knowledge acquisition it is with the recognition that there is no observer-free science and that accounts of objects are never free of the observer (Denzin & Lincoln, 2000). Josselson (1996) identified that in narrative work one is engaged in an interpretive enterprise in every phase of the work. Therefore, it is without doubt that a different interviewer and writer would have produced somewhat different narrative profiles, because as much of the telling of an experience is in the listener's interpretation of it. As a researcher new to qualitative research it is also important to acknowledge my limitations, as both an interpreter and as a writer, which may have impacted upon the accuracy of the profiles constructed. Nonetheless, these limitations were sought to be minimised through thorough education of interview and analysis methods, several pilot interviews, and the opportunity given to participants to review their transcripts. In addition, original transcripts and completed profiles were compared by another researcher for interpretational and analytical errors.

Profile construction

In total, five distinct profiles were crafted and each was given a fictional name to aid reference and discussion. Three of these profiles represent reflections of the IET experience, and the other two represent reflections of the two 'moderate' intensity exercise bouts under the known versus unknown duration conditions. The presentation and discussion of these profiles has, therefore, been divided into two parts.

❑ **Part 1: Reflections of the IET experience.**

As mentioned previously, three of the five profiles are descriptive of the IET experience (i.e., they represent each of the three interview selection criteria detailed on p. 116-117, and, therefore, each is the result of the unification of two participants' interview data):

- Profile 1A. Melanie's IET experience: Decline in affective valence began at ~VT;
- Profile 1B. Jen's IET experience: Decline in affective valence began after VT;
- Profile 1C. Ellen's IET experience: Positive affective valence was reported throughout the IET.

Each of these profiles has been constructed to take the reader on a journey with the participant from the beginning of the IET to the end. Each narrative then finishes with the participant's reflection of the experience in relation to their previous physical activity experiences.

- **Part 2: Reflections of the known vs. unknown duration exercise experiences.**

Two of the five profiles represent opposing views of the 'moderate' intensity exercise bouts detailed in study three, and, therefore, each profile is the result of the unification of three participants' interview data:

- Profile 2A. Fran's aversion towards the UD condition;
- Profile 2B. Justine's aversion towards the KD condition.

Both profiles begin with an account of the least preferred condition first, which is followed by a comparison of this with their experience of the other condition. In keeping with the profiles in part one, each narrative in part two also concludes with the participants' reflections of their experience in relation to previous physical activity experiences.

Each profile is accompanied by demographic data for the 'individual' and graphical representation of their responses to the psychometric measurement scales employed in studies two and three (i.e., sessions two and four described in Chapter Three), which were calculated using the mean values of the individuals that contributed to each profile. [Brackets] surround words that have been added to improve the comprehension and flow of the dialogue, but all other words are the participants' own. In addition, the names attributed to each profile are fictional in order to protect the identity of the participants.

It is important to validate the decision to create profiles that combined both qualitative, narrative profiles and quantitative, graphical data in order to explore theoretical principles (i.e., that of the dual-mode model; Ekkekakis, 2003) from a post-positivist perspective. Philosophically, it may be considered difficult to justify how narrative profiles 'fit' within this approach given that they are often placed at opposite ends of the research methods spectrum, with the nature of post-positivist methods being particularly deductive and that of vignettes principally inductive. However, in this study the differences between these approaches were considered complementary rather than conflicting as they provided the different ingredients necessary to create truly comprehensive pictures of individually varied exercise experiences. Whilst the quantitative data formed the necessary outlines of these pictures, the narratives provided the colours and hue. This approach was in keeping with Richardson's (2000a) contention that "Science is one lens; creative arts another. We see more deeply using two lenses. I want to look through both lenses, to see a 'social science art form'." (p. 937).

Creating narrative profiles from interview material is considered by some as an act of interpretation and analysis in itself (e.g., Seidman, 1991), and many researchers therefore leave the profiles to speak for themselves. However, considering the mixed-methodological approach, there were a number of topics broached by these profiles that appeared to call for further analysis and discussion within the context of the theoretical framework. Therefore, comparison and examination of these profiles follows both parts one and two.

Criteria to Evaluate the Profiles

Richardson (2000a) suggested five criteria for evaluating creative analytic practices. These criteria, as modified by Parry (2007) for use with the judgment of vignettes, are outlined below to aid the reader in interpretation and assessment of the profiles in the present study.

1. *Substantive contribution of the text.* For a text to succeed substantively, it must contribute to a deeper understanding of social life including being grounded or embedded in a human perspective. The human perspective must then inform the

ways the text itself is constructed. For example, if people make sense of their lives through stories, then a vignette or a short story may be the best way to represent their experience.

2. *Aesthetic merit.* Aesthetically, a text should draw the audience in and encourage them to form their own interpretation of the social world being presented. The text needs to be complex, interesting, engaging—in other words, not boring!
3. *Reflexivity.* The author of a text needs to be clear about how the text is created including the role of the researcher. In this sense, the authors of a text need to hold themselves accountable for the knowledge they put forth. The author needs to disclose any ethical issues surrounding the creation of the text and bring adequate self-awareness/self-exposure to the text so that readers are able to judge their point of view.
4. *Impact of the text.* Richardson (2000a) suggested asking how the text affects you as a reader on an emotional and intellectual level. A good text created through creative means should generate new questions, motivate you to write, and/or to try new research practices. Because texts created through creative analytic processes draw the reader in and are open for interpretation, they often motivate readers towards social action or change.
5. *Expression of a reality.* A text needs to convey an embodied sense of lived experience. A text needs to be believable and convey a credible account of a cultural, social, individual, or communal sense of the "real" (Richardson, 2000a).

One of the main challenges faced when creating these profiles was to ensure that the profiles had an impact and maintained aesthetic merit, whilst also ensuring the resulting text was substantive. The resultant profiles are long, and may at first appear to include information that is superfluous to the research question (e.g., detailed contextual information). However, the decision was made to include this information in the profiles as it was considered essential to the exploration of the exercise experience. As Kerry and Armour (2000) acknowledged, personal history is central to the uniqueness of experience:

> "It is the recognition that these personal histories lead to a unique perception of different experiences and that this personal history cannot be bracketed out; it is fundamental for interpretation." (p. 9)

Moreover, in some cases the participants clearly felt that it was necessary to share this information as a component of their exercise experience, whether it was something they had considered in the past or something they had realised for the first time as a result of participating in the study. The documentation of this information may also be useful to readers in forming an understanding of and appreciation for the coalescence that makes each experience distinctive.

Profiles

Part 1: Reflections of the IET experience

❑ **Profile 1A: Melanie's IET Experience.**

Decline in affective valence began at ~VT: "I felt lethargic and a bit frustrated: it was really dawning on me that this was going to be hard"

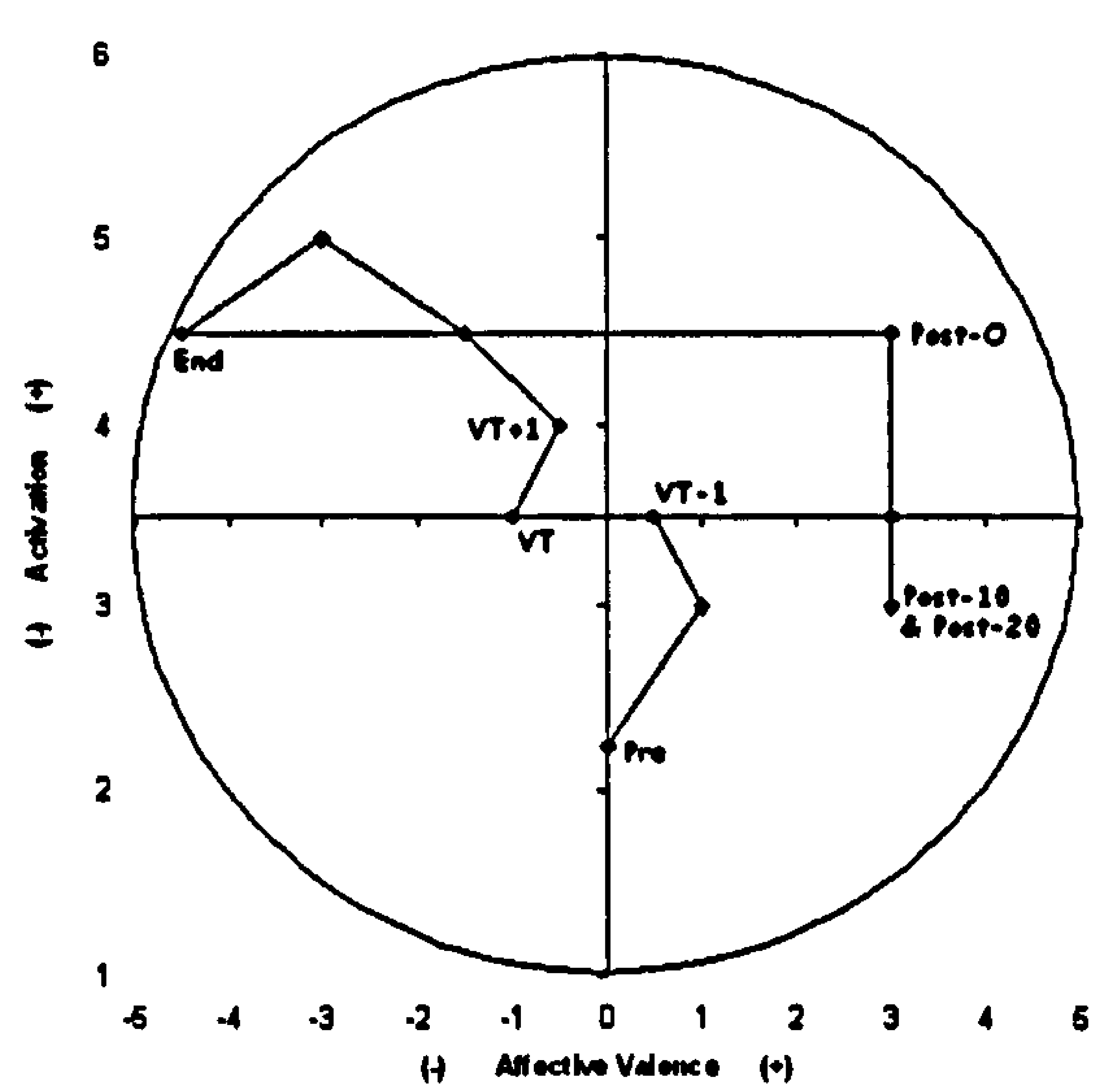
Table 6.1. **Descriptive Statistics of participants that contributed to 'Melanie's' profile.**

Participant	A	B
Age (yrs)	28	25
BMI	18.5	20.5
VO2peak (ml.kg.min^{-1})	40.98	31.98
VT (ml.kg.min^{-1}; as % of VO2peak)	19.67 (48%)	16.63 (52%)
IET Duration (ramp phase)	10m 25s	10m 53s
Time VT occurred	4m 6s	4m 0s

"The level of intensity felt pretty easy [when I started]. Obviously I had to exert myself a bit to get the pedals moving and shifting, but it was fairly easy and I was just waiting for it to crank up. [My feelings were] probably pretty neutral; I was expecting to do exercise but I wasn't overly excited about it as I didn't really know what was going to be coming. You start off at a very even pace and there's no resistance; you think 'if this is all I have to do then fantastic'. As we got into the exercise I think I just concentrated on being there rather than thinking about what was going to come,[but after a while] I was [feeling] really uncomfortable. The thing on my finger was hurting me, and then the chair was hurting, so that brought me back to just thinking about doing the exercise. Saying that, there were times when I drifted off and thought about work, people and things, so it wasn't a constant stream of consciousness on the exercise; I waned and came back.

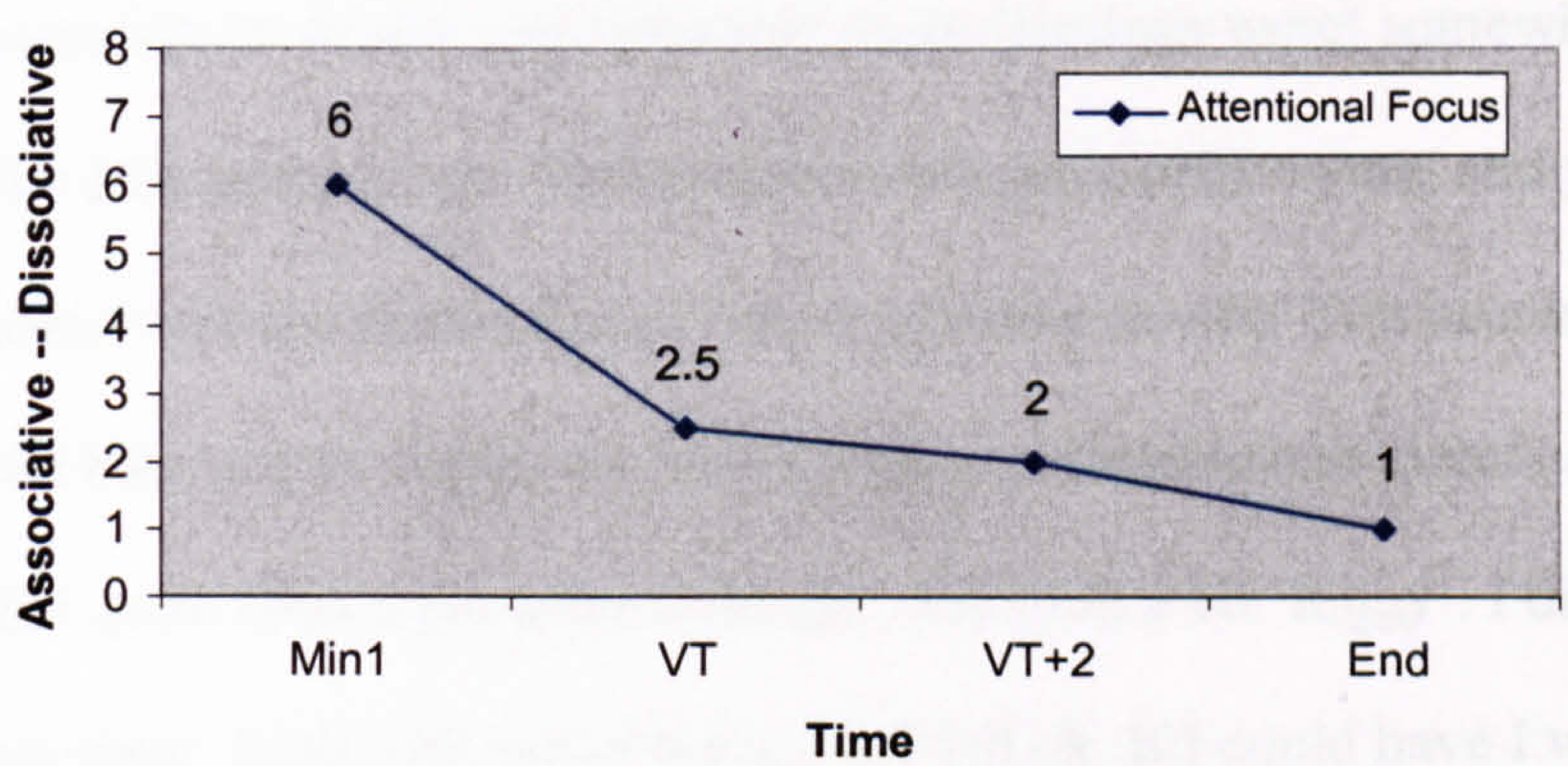
Gradually it got harder and harder, but I felt I could keep up with it. Then it did start to get really hard, my knees started to hurt, and my bum started to really hurt, so my mood deteriorated. [When] the resistance came in I think it became harder to switch off. At the start you can just think, 'I'm having a nice time' or whatever, [but] as it starts to get physically challenging it becomes more difficult [to do that]. I knew that I would find this challenging because I haven't done anything physically demanding for a long time. I just thought 'well, if I just think nice thoughts maybe that would be a way to get through it'! [Yet when] it got harder that kind of focused [my] mind to think, 'just keep going' [and my focus was] on that revs per minute marker thing at the front [of the bike]. That's all I was thinking about: trying to keep it on 60. Initially, as the resistance came in, I probably did think 'I can't do this' [and] 'this isn't just going to come to me, I need to put something into [it]'. It was weird, actually, because I felt almost worst midway through the exercise [when] I felt kind of tired. I [was] lethargic and a bit frustrated: it was really dawning on me that this was going to be hard and [that] maybe I'm not going to be able to continue. I find it quite hard to explain - especially when you're not used to the sensations. It must be over two or three years since I've done 'proper', concentrated exercise like that.

Figure 6.1. Affective responses of 'Melanie' before, throughout and after an incremental exercise test to volitional exhaustion, plotted in circumplex space.



[Then] I got to a point where it was really, really hard and I was just [thinking], 'oh god, how long is this going to get harder [for]?' But you think beyond your physical state, you know? [You think] 'Yes I'm knackered, I'm finding this really hard', which was how I definitely felt towards the end, [but] I'd say I probably *wanted* to continue. My mind set was 'I want to continue but my body's not letting me'. Physically you feel like you have less control over your limbs. Of course you can feel your legs but you have less control over them, your legs won't do what you want them to do in your head. I guess I did have a little strategy with regards to that rev count thing, it was to always try to keep it slightly above what I was asked to do, because I thought 'then I've got a bit of space left to have a bit of a rest'!

Figure 6.2 **Attentional Focus of 'Melanie' throughout an incremental exercise test to volitional exhaustion.**



As it was getting harder and harder [I] was like, 'come on, you've got to try to get it back up to 60', but then I thought 'there's no way I'm going to get it back up to 60'. Short of some sort of injection of energy into my legs I wasn't going to do anything! So I [thought] 'oh well, I can't really do anything, I'll just keep going but [I'm] not going to get it back up there'. [Then] I felt like 'god, I'm knackered and I can't do this, I can't be arsed with it!' It was probably [for] about 30 seconds or so [that] it felt like that, where my pace was starting to drop. I was quite worried before we started how would I know when to stop, [but] it became clear very quickly when to stop: I couldn't continue! It wasn't a case of thinking 'right ok, I'm going to stop now' it was more a case of 'I *can't* continue'. That was quite sudden.

I was feeling intensely uncomfortable [when the load came off]...but I guess there are different kinds of uncomfortable. When it was coming up to the peak intensity [it] was physically [uncomfortable in] my chest. I was breathing heavily, I was hunched up, [and] my heart was going quite fast. You know, I was really physically hurting through exertion. Then afterwards I felt really uncomfortable just by the surroundings, [like] the equipment interfering. It [was] unpleasant still, but like a different scale of unpleasant. When you're exercising, when you're into it, especially when I reached the point where I couldn't continue, that was all I was concentrating on. The unpleasantness I had after that peak intensity was... a different kind of pain to just exertion. Things were hurting [that] I only noticed after the peak; I didn't notice them at the high intensity, it wasn't until after that. Both [feelings were] somewhat negative, but negative for different reasons. You become more physically aware, and you become a bit more aware of your surroundings [when you slow down]. You become aware of the fact that the bike you're sitting on feels a bit uncomfortable and there's spit all over the place! I felt quite tired, I felt quite lethargic, and I felt a bit 'foggy'. I didn't feel altogether together. I felt a bit out of sorts, but I felt ok. If I could have I would have stopped and got off [the bike] and walked around; that would have been much better. [At that point I was] feeling pretty knackered, but I had exerted myself so I was like, 'oh well, the worst bit's over and done with, at least you know it's going to get better'. At the time [there were] one or two minutes left [of the cool-down, and] I was just thinking 'this is the longest minute!'

When it stopped I felt really happy, and I was really in a good mood again. Straight away I was feeling quite vibrant, quite alive. Then after [about] 5 minutes I [felt] quite sleepy, but good. I could have quite easily fallen asleep! Now I'm still quite sleepy, but a bit more awake, [a] bit more alert. I feel much more clarity, I feel much more conscious if that makes any sense? I feel good, I feel emotionally positive, but I can also feel that I've done exercise; as in my legs are a bit wobbly [and] my cheeks are probably a bit red. I like that feeling of having exerted myself. The thing I've never really got about exercise is that sometimes you just feel knackered afterwards, and I've always thought 'well I don't really want to feel tired', you know? But I do feel more awake [now] than I did when I walked in this room, definitely, and I feel pleasant because of that.

I was a bit nervous before [I started exercising], and I was thinking 'oh God, [I'm] not feeling 100% today, will I be able to do it? I hope so'. I was [also] a bit nervous of how I'd look, having reached a peak where I couldn't continue; I was aware that I [would be] sweating and stuff. Before - this week and as I started [exercising] - I was thinking 'what will I look like'. [I was thinking] 'I don't know you girls that well, and I'm going to look like a right state. I haven't done any exercise for ages so I know that I definitely won't be able to carry this off and be really cool about it'. Normally I do feel quite physically confident and I tend not to put on weight; there's not many times these days where I do feel under-confident physically. But I think there was a time [during the exercise] when I felt quite self conscious. I think that you're also kind of aware of the setup. If this was a gym you could get a water bottle and you'd maybe have other things around you, distracting you. You're quite aware of yourself and your surroundings with that setup and that equipment. But I think once the exercise takes over, once the exercise becomes very physically demanding, that is what is at the forefront of your mind. [I was thinking] 'How can I keep on going, how can I push myself? Can I push myself?' That was at the forefront as things got harder. Maybe as things were leading up to that I was thinking about how I looked and [was] concerned about that, but once [I] got to that point I [wanted] to continue. Once you're actually *in* the exercise you've got to go with it.

[On reflection], I really found [the whole exercise bout] quite tough, physically. I wouldn't say [it was] a bad experience, it was just not a 'happy' feeling! But I do think that is possibly to do with my attitude towards exercise. I feel quite aware of how your mind set can affect how you do your exercise, and [the] experiences of exercise I had before [were] quite negative, I think because of my mental state at that time. I'm always slightly aware that I don't feel like the sportiest of people, [and] I'm not necessarily familiar with how you feel, [or] maybe how you should feel; [but] I suppose everybody feels differently. I'm also quite conscious that when I did exercise [regularly] before – two or three years ago - I pushed myself quite hard physically, and I wouldn't say that it was a happy experience. If anything, I found it kind of self-punishing. You know, you sort of push yourself to your limit. I don't think I got much out of [it], despite [the fact that] I was fitter, I was physically more lean, [and] I was more toned. But it was physically demanding and it was unpleasant. I'm aware that I'm saying [that] I viewed exercise negatively in retrospect, looking back on a period of my life where there were several other things that were fairly negative. I think that I was probably quite miserable and so when I [went to the] gym that was nice, it was quite isolating. [Now] I'm not sure it was the best exercise practice to be doing at a time when I was feeling a bit down, [but] I went into it thinking that it would be good to have some time to myself; [that] it would be good to get fit physically [and] that would help me get more positive.

My boyfriend is particularly sporty and he has such a different attitude to sport. I think he sort of looks forward to that feeling of [being] aroused, I suppose, [being] pumped up and getting a kick out of it. I'm not sure that I'm there yet. There are other things I do to have those feelings of pleasantness, happiness, and so on. I suppose studying is a bit like that, because it's not like I really want to go into university every day and reading is not an enjoyable thing, but I like how I feel afterwards... that's the only kind of comparison I can draw. I don't know if "positive" is the right word to use or if "negative" [is] the right word to use - it's just a different state when you're exercising. Doing exercise is like a different feeling, it's a different kind of process that you seem to go through.

❑ **Profile 1B: Jen's IET Experience.**

Decline in affective valence began after VT: "I was fired up but I wasn't really enjoying it...; [it] was quite painful!"

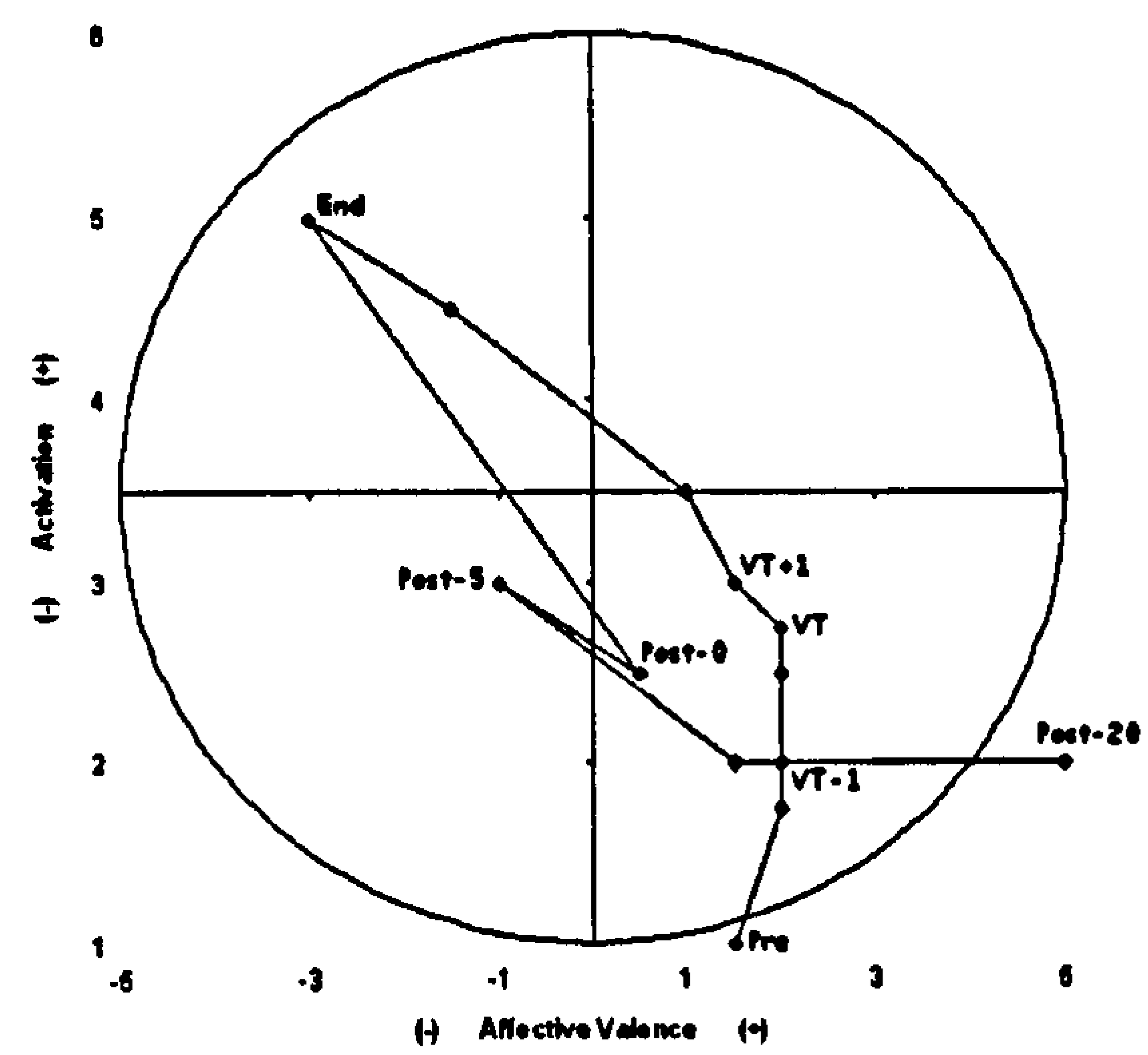
Table 6.2. **Descriptive Statistics of participants that contributed to 'Jen's' profile.**

Participant	C	D
Age (yrs)	21	19
BMI	26.9	23.9
VO2peak (ml.kg.min^{-1})	27.45	25.51
VT (ml.kg.min^{-1}; as % of VO2peak)	14.00 (51%)	13.01 (51%)
IET Duration (ramp phase)	9m 29s	7m 20s
Time VT occurred	3m 20s	2m 0s

"I started off feeling quite lethargic, then [I] started cycling and it was quite easy. At first I started off not being that bothered, [and] I felt quite bored. [I was] just thinking about what I was doing afterwards, like tonight. I felt fine, I felt normal; I was just in a pleasant state of normality, really. I was thinking about my fitness levels and thinking about how I ought to do more exercise than I do at the moment. And that my attitude towards exercise is too...I'm too lethargic generally, really. I enjoy exercise while I'm doing it because when I'm actually doing it I feel good about myself and I feel like I'm pushing myself more than I normally do. I was [also] thinking about the other people who are doing this [experiment]. [I] thought 'am I doing as well as them? Am I answering the right questions in the right way? Am I going about it all wrong?' [And], you know, 'am I as good as other people when it comes to physical exertion?' [But I] wasn't particularly happy or sad or anything.

Then [as] it started to get harder I was getting more and more fired up, I wasn't feeling as tired. [I mean] I [did feel] like my legs were tired, but I was getting a bit less lethargic. As it got more intense I was thinking about the sweating and about my heart rate, and stuff. [I was] getting more into it, thinking I've got to keep pushing myself and keep going further. I felt my muscles were aching quite a lot and I felt like my heart rate was really going; that's about it really. Physically my muscles were aching, but that made me feel quite good because I knew that I was working my body and tiring it out. It was quite enjoyable when I was pushing myself. Yeah, I liked pushing myself quite hard, I [felt] like I [was] actually achieving something.

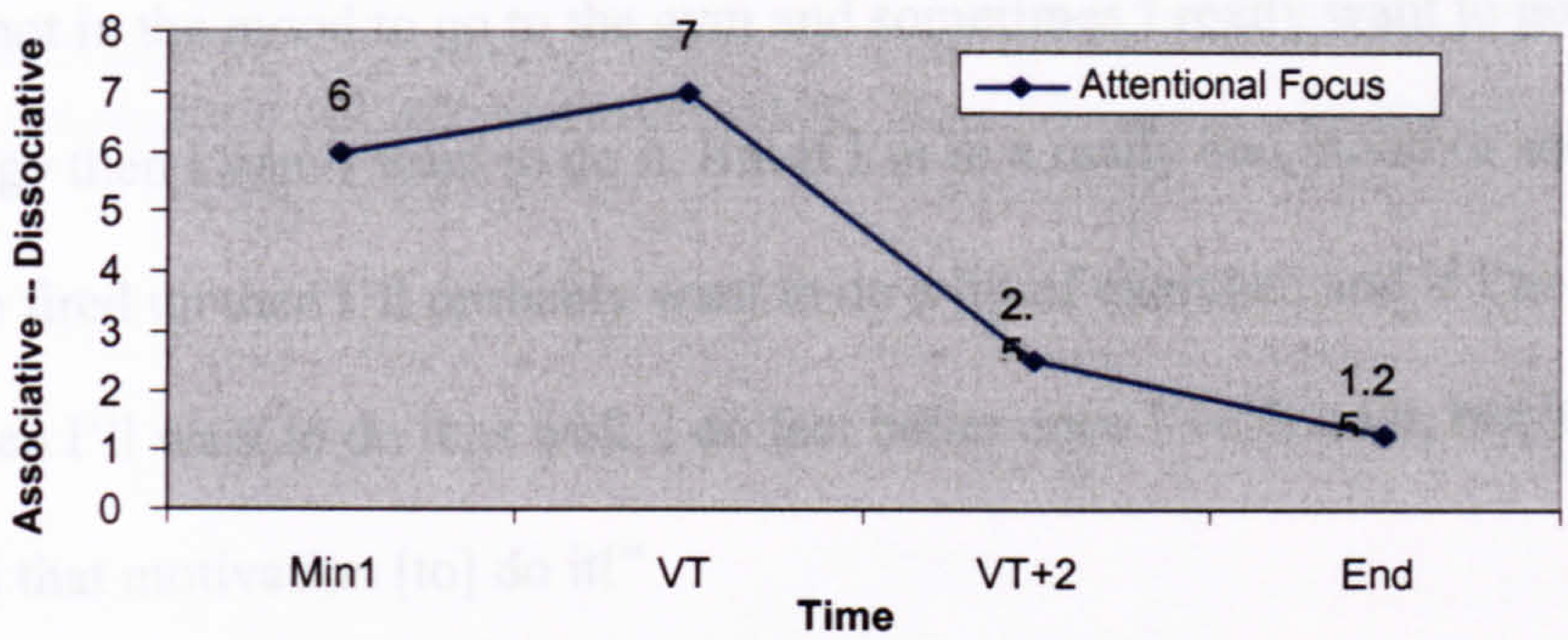
Figure 6.3. **Affective responses of 'Jen' before, throughout and after an incremental exercise test to volitional exhaustion, plotted in circumplex space.**



As it got harder and the hill got steeper, if you like, it did get more unpleasant physically because obviously I was working my body harder. I felt really tired, but still quite fired up. I was fired up but I wasn't really enjoying it as much; [it] was quite painful! I probably enjoyed it more in the middle, before it got too hard. The final bit wasn't very nice because I felt exhausted and I just didn't really want to go on, but I was pushing myself to carry on a little bit more. I was completely concentrating on how hard it was, how much my legs hurt, and how I couldn't breathe! I just felt very, very tired, very out of breath, until the point where I just couldn't do any more. I felt that if I did go on I would start doing my body damage rather than good, and just faint or fall off the bike!

[When the load came off] I was a bit annoyed that I couldn't push myself further, [but] it didn't hurt my legs any more! [I] probably [felt] relief that it was over [and I was] still quite fired up. I'm not sure that I was really feeling negative [at that point], more neutral probably. I didn't feel particularly wonderful because I'd just done loads of exercise, [but] I wasn't really thinking about how I was feeling because I was still kind of exercising. When I got off the exercise bike I was tired [and] probably a bit miffed that I couldn't have done better. [Then] it actually hit me that I'd done loads of exercise and I didn't feel too good. But now I feel fine. If I hadn't had the slow recovery, where I was just pedalling and it was really easy, I probably would have felt quite bad at the end; but I think because we did that I [feel] fine.

***Figure 6.4.* Attentional Focus of 'Jen' throughout an incremental exercise test to volitional exhaustion.**



I'd say [the exercise experience] was quite pleasant [overall] because we built it up slowly; it was like a gradual, intense workout rather than just going straight into a really strong exercise bout. I felt that I was warming myself up mentally and physically, and then warming myself down for a long time afterwards, [so] I quite enjoyed it in a way. I felt that I was doing it properly and that it wasn't as bad as, say, just suddenly sprinting or something, and not preparing myself. It was quite hard at the end [but] it was a good test to see how hard I could [work]. [I] hoped I could have done better, but I didn't (laughs). [Beforehand] I thought I could do quite well at it; is that really cocky? I've done something similar to it before; I [ran] a 6 mile marathon [which] was a last minute thing. My boyfriend was doing it; he said that one of his friends had backed out and [asked] did I want to do it? I hadn't done any training [but] I knew I could do it. [And so] I knew [that] if I just put my mind to it I [could] do [this exercise as well]; I knew that I could push myself quite hard.

I like to push myself, but it does knacker me out quite a lot and then I have to go and rest! Then I [think], 'oh, I don't want to push myself that hard again'. But I am looking to start becoming a lot more active than I am because I'm very interested in my health. I don't want to become overweight either. I know that I should be more active because [of] the inherent problems you get with not exercising, such as heart problems. I don't want to get to a stage where I'm overweight at all – for health reasons and for vanity reasons as well. So recently [I've tried] to go to the gym, but [it's] irregular exercise. [I go] occasionally but not on a regular basis, and since I've come to uni that's decreased even more. I've been to a few aerobics classes but it's all very sporadic, it's not regular yet. [Plus] if I push myself really hard I normally feel a bit crap afterwards and don't want to do it again! It depends what kind of mood I'm in, as well. Sometimes I'm just not in the mood to go to the gym and sometimes I really want to go. If I'm tired and groggy then I won't want to do it. But if I'm in a really bad mood or something, if I'm quite fired up then I'll probably want to do a bit of exercise; and if I'm feeling quite happy then I'll want to do it as well. I do feel better once I've done it, but it's just [finding] that motivation [to] do it!"

❑ **Profile 1C: Ellen's IET Experience.**

Positive affective valence was reported throughout the IET: "It was like I was high or something!"

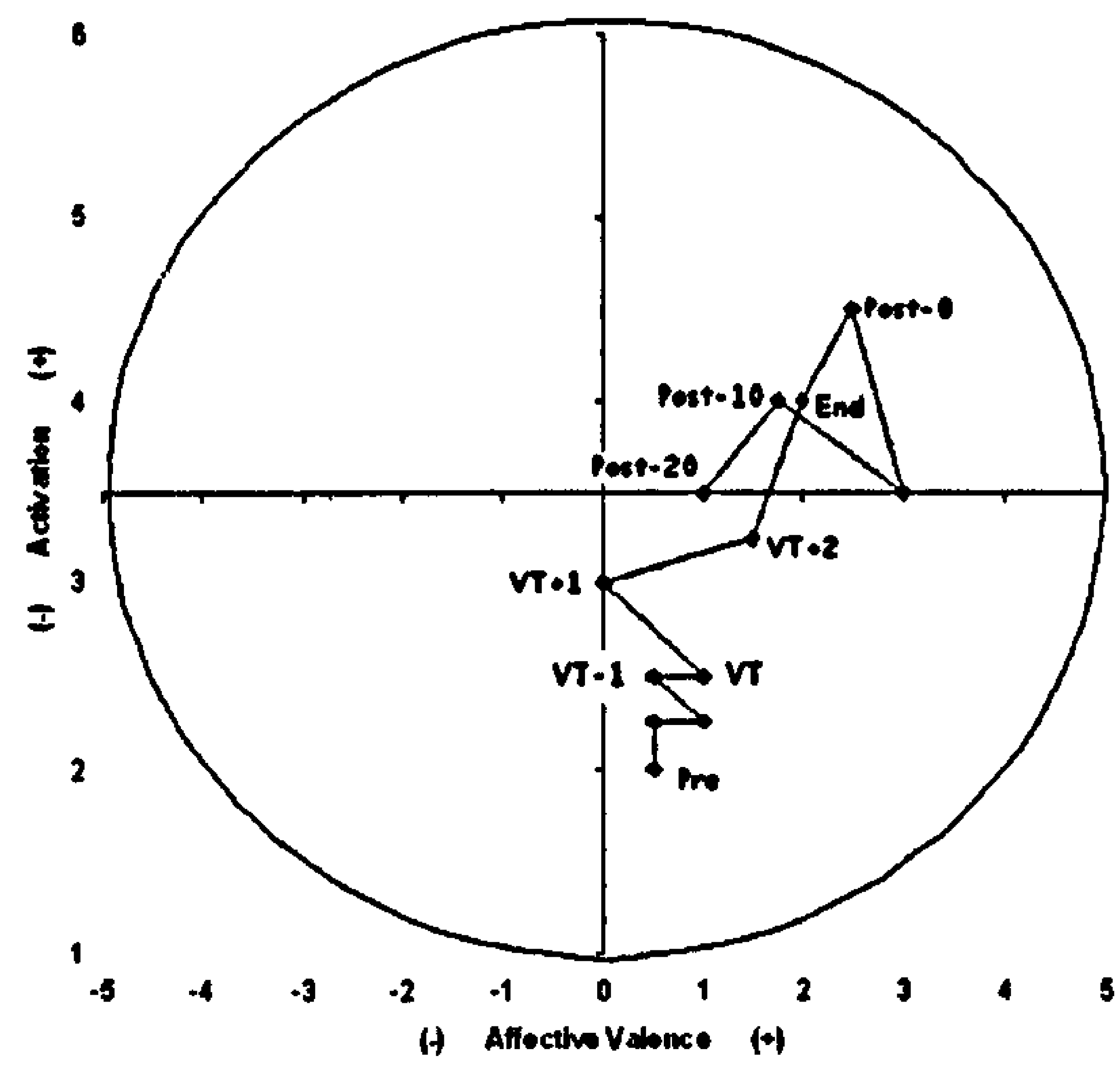
Table 6.3. **Descriptive Statistics of participants that contributed to 'Ellen's' profile.**

Participant	E	F
Age (yrs)	21	23
BMI	21.5	23.8
VO2peak (ml.kg.min^{-1})	39.00	32.57
VT (ml.kg.min^{-1}; as % of VO2peak)	24.18 (62%)	16.29 (50%)
IET Duration (ramp phase)	13m 32s	9m 8s
Time VT occurred	7m 11s	3m 22s

"I didn't really know [what to expect from this exercise session], I was just going to carry on until I really couldn't go any further. I thought, 'I'll just keep going and see how far I can get and not worry too much about whether I end up being a complete wimp and stopping really early'. [So, I] probably wasn't very confident to start with, [but] I was quite relaxed. There wasn't very much going on, [although] perhaps [I was] slightly apprehensive about how hard it was going to get. As it started to progress nice and slowly I calmed down a bit because [I realised that] it wasn't going to suddenly hit me, it [was] just going to be gradual. When it was sort of average effort it was quite enjoyable, just keeping the rhythm going; [it] was fine but it was quite boring.

I was concentrating on keeping the revs steady because that was actually quite hard! I was [also] thinking about what I've got to do in the lab today, because obviously with it being this early in the morning that's what's on your mind. That was it really, I don't think I was thinking about anything else; you kind of turn your mind off.

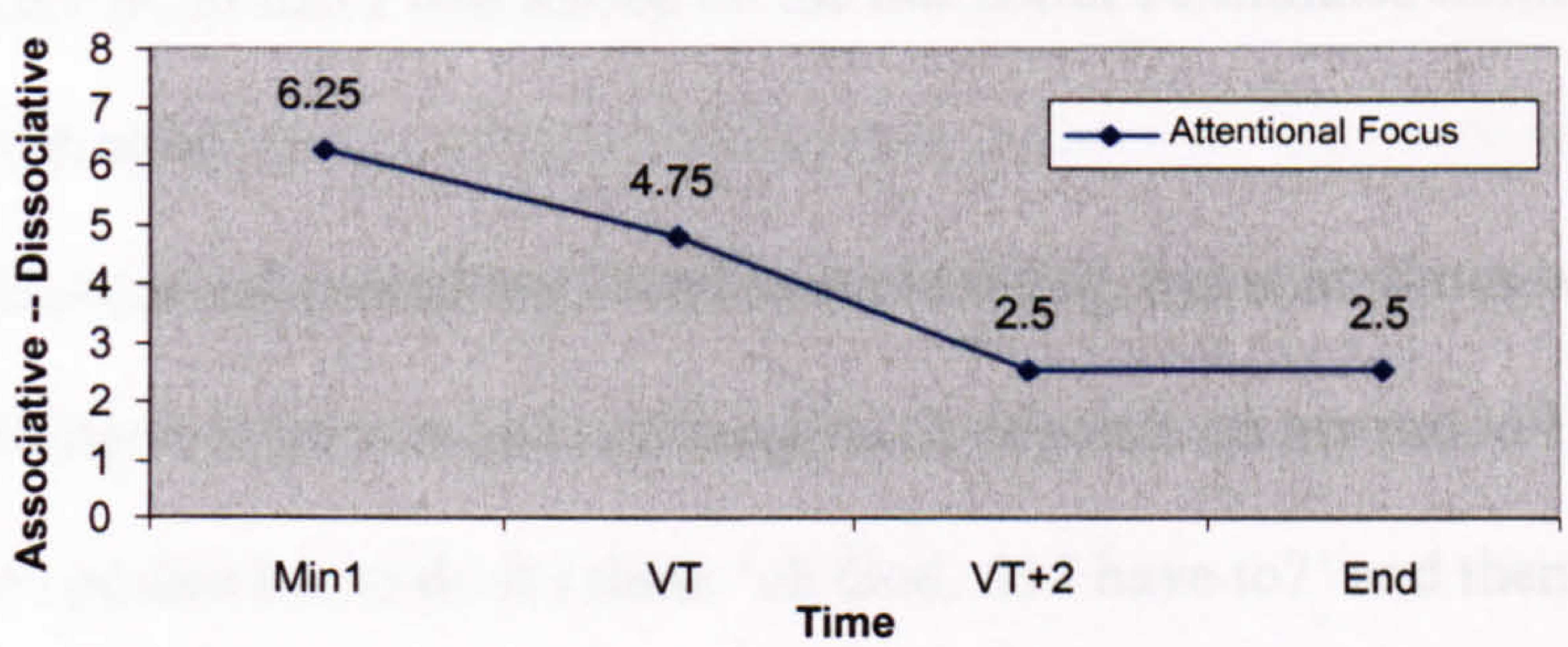
***Figure 6.5.* Affective responses of 'Ellen' before, throughout and after an incremental exercise test to volitional exhaustion, plotted in circumplex space.**



I probably started to wake up when it became quite hard, and I forgot about those things. I [became] sort of more detached from it and I thought 'I don't care; I'll worry about that later on'. I was thinking more about things like [the fact that] my mouth was feeling dry, and I was feeling the tightness in my legs and thinking, 'oh, what's happening?!' I think it took up until [that point] before I felt any different. [I had] to make more effort, [and] there were times when I kept dropping the revs and [had] to build it back up again. Those were the points where I actually started to feel more awake, I started to feel like I had more energy. But that didn't necessarily make me feel happier, I felt happier even later on than that. I probably felt happier just before the end.

Once I started getting out of breath I started getting the 'kick' and started to enjoy it. I started to think 'yeah, lets go!' It was like I was high or something! Below [the 'kick'] it was boring, and then when you got that kick it was interesting and exciting, you just felt like you had so much energy! It was a challenge [and] I didn't want to give up until I really had to. I was thinking, 'shall I give up now? No I can go a bit further, I'm not dead yet!' You know what I mean? I kept thinking I could push a bit further. That was really the point where I felt best. I had a strange kind of split because on one side I was thinking 'yeah, come on, this is good, I can do this!', and on the other hand I was breathing really heavily and the sweat was pouring off me. It felt like I should [have] been [thinking] 'oh my God, I can't stand this', but it was a challenge and I was enjoying pushing myself. I did enjoy it more as I [went] on, but it was more of an emotional enjoyment than a physical enjoyment. I noticed the physical symptoms, but it wasn't like my lungs were burning or anything like that. They were kind of background – they weren't very pleasant, but they weren't really the main thing I was feeling. I was [aware] that I was sweating, but it wasn't [at] the forefront of what I was thinking about, [and] my legs weren't hurting *too* much. It was as if what you're feeling in your body and what you're feeling in your brain are two different things; you know that you're working really hard and you know that you should be feeling awful, but you're buzzing and you're thinking, 'I can go forever'! Despite the fact that your lungs are burning, you can barely breathe, and your legs feel like they're lead. You've just got this separate adrenalin rush, or something in your head going 'yeah, yeah, yeah; come on, come on, come on!'

Figure 6.6. **Attentional Focus of 'Ellen' throughout an incremental exercise test to volitional exhaustion.**



Maybe I'm fitter than I thought I was! [Maybe] it was the challenge – I felt a sense of [achievement]; but I hadn't achieved, I was achiev*ing*! And I wanted to push myself more – I wouldn't say I had something to prove, but I was enjoying pushing myself.

Towards the very, very end I started to feel like [I was] gasping for breath, and I started to really wish I [could have] a drink of water because my mouth was so dry. Then there was a sudden slump for a few seconds [and] it was quite difficult. It wasn't that I felt tired so much [as] my legs just wouldn't cooperate any longer; lactic acid basically! It just [got] to a point where I thought 'they're just going to stop any minute now'. Yet, to be honest I don't think we actually went high enough [for it to be really unpleasant]. [It] stopped just as I was starting to think, 'oh, maybe I can't go any further'. Maybe if you'd [let me] carry on until I fell over! I know that wouldn't go down very well, but I hadn't reached a point at which I was finding it *impossible* to go any further before you stopped it.

It wasn't as bad as riding your bike or running normally, maybe because it started so slowly I almost didn't realise I was working so hard. I do generally feel better when I'm exercising than when I'm not, even though I don't do it at all! That's really weird though; [it] really surprises me that I'm saying that. Surely pushing yourself so that your legs are killing you is unpleasant? It just wasn't – your heart rate's going but you just feel ok; simple as that. I'm definitely more awake now. I was falling asleep when I came in, in fact I *was* asleep on the bus about 10 minutes before I came in, and I'm buzzing now!

[Exercise is] something I tend to avoid doing, but sometimes when I get into it and I'm doing it, it isn't as bad as I imagine. It depends on my mood I think. Generally, if someone pushes me to do it I think 'oh God, do I have to?' and then I start to enjoy it as I go on. Often it's just getting around to doing it. If you're sat in the house and somebody says, 'shall we go swimming?' [I just think,] 'It's much easier just to stay here thanks!' If somebody magically transported me to the swimming baths and put a swimming costume on [me] that would be different! I prefer doing exercise outside. In the last year or so I've started cycling [to university]. I brought my bicycle back with me last September, so I've only really been doing it for about 9 months or so. It takes me less than 5 minutes to get to uni, though, so it doesn't really feel much like exercise. I used to run in the mornings [but] it didn't last very long – more because I couldn't get out of bed [than] because I didn't particularly want to run! A couple of times I've been to the gym, [but] the running machine in the gym is not like running [outside], and the cycling machine isn't like cycling [outside].Why do it in the gym when you can go out and do it properly?"

Discussion of Part 1: Reflections of the IET Experience

These three profiles were crafted to represent the range of IET experiences amongst low-active women, and the factors that contribute to those experiences. First, it is worth exploring the temporal thought patterns that were evident in all three profiles. The three experiences were similar in the respect that they all documented more dissociation at the beginning of the exercise bout and a difficulty in dissociating from the exercise-induced physical sensations as the intensity increased. In fact, all narratives referred to an acute awareness of physiological responses to the exercise, such as deeper breathing and increased heart rate as the IET progressed. The difference between them, however, appeared to be in their interpretation of those sensations and how much these perceptions contributed to their affective experience, especially as the exercise intensity increased. These observations were reflected in the pattern of all three participants' responses to the Feeling Scale and Felt Arousal Scale, when plotted in the circumplex space (see Figures 6.1, 6.3, and 6.5).

For example, 'Ellen' reported that she enjoyed pushing herself and that it was more of an emotional enjoyment than a physical one. She perceived the physical sensations experienced during the final stages of the IET as "background - they weren't very pleasant, but they weren't really the main thing I was feeling". However, 'Melanie' and 'Jen's' profiles both indicate a relationship between the awareness of pain, heavy breathing and physical discomfort and changes in reported affective valence. For example, 'Jen' reported enjoying the feeling of her muscles aching when the exercise first became challenging, but that when it became very difficult she "wasn't enjoying it as much". By the end, she acknowledged that "the final bit wasn't very nice because I was exhausted I just really didn't want to go on..." Likewise, 'Melanie' identified that when it started "to get really hard, my knees started to hurt, and my bum started to really hurt, so my mood deteriorated". These perceptual differences could be indicative of the influence of *perceptions* of exertion upon affect at high exercise intensities, and may have been manifested as the variation in magnitude of affective valence that was observed towards the end of the IET in study two.

These profiles also provide support for the contention that cognitive appraisal factors governed perceptions of affect at the beginning of the IET when the intensity was relatively low (probably below VT). 'Melanie', whose affective responses declined approximately at VT, appeared to experience social physique anxiety during the initial stage of the exercise bout (manifested in worry about how she appeared to the researchers), and she also reported consciously trying to employ strategies to "get through it". Likewise, 'Jen' referred to her consideration of how 'well' other study participants were performing – she was clearly struggling with the lack of information on how she was performing compared with her peers, which is known to be an important source of perceived competence (Bandura, 1997). Recall that study three showed that self-efficacy perceptions varied and influenced affective responses *during* exercise. This example, provides qualitative support for that phenomenon in action, and is one of many similar references within these profiles that appear to point toward the continual search for sources of self-efficacy as central to the exercise experience.

'Melanie' identified that at the beginning of the exercise bout, awareness of herself and her surroundings (i.e., cognitive appraisal factors) influenced how she felt at first, and that as intensity increased she could then no longer focus on them. Her explanation for this was that "once the exercise becomes very physically demanding, that is what is at the forefront of your mind". She identified that she was also very aware of peripheral physical sensations at first (e.g., the uncomfortable pressure of the oximeter on her finger and the seat hurting), and these sensations also appeared to disperse when the intensity increased further and her focus was directed towards the sensations associated with physical exertion. In addition, she noted that "things were hurting [that] I only noticed after the peak" (i.e., after the cool-down). These "things" included peripheral symptoms, such as being uncomfortable sitting on the bicycle, that she reported being focused upon during the initial stages of the exercise bout. These examples from 'Melanie's' profile provide evidence for the existence of intensity-dependent dual influences upon affect. Similar phenomena are referred to in all three IET profiles and, thus, signal support for Ekkekakis' (2003) dual-mode model. To recap, the dual-mode model suggests that affective responses during exercise are the result of the interplay between two influences, cognitive appraisals and physiological cues. The ratio of their influence changes across exercise intensities: cognitions dominate until they are over-ridden by interoceptive cues that are associated with increased physical demands upon the body. That is, cognitive appraisal becomes more difficult once the intensity becomes too demanding for the body to maintain a physiological steady state and, accordingly, affective responses deteriorate.

Although Ekkekakis' theory obtains a great deal of support from these profiles, it is interesting to note that there are clearly exceptional situations. For example, it was noted earlier that 'Ellen's' perception of the physical demands of high intensity exercise, and the interoceptive cues associated with that, did not appear to dominate her perceptions of affective valence ("they weren't really the main thing I was feeling"). In these distinctive, possibly rare, situations, other factors must play a role in the 'pleasure' derived from high intensity exercise. Possible explanation for this can be found in participants' physical activity histories and attitudes as distinct differences in these factors were reflected in the three profiles.

'Melanie' elaborated on a previous negative experience of physical exertion and the association that she has made between that and a negative period in her life. She also appeared to hold a negative exercise identity, continually referring to herself a 'not sporty'. 'Jen' also attributed the feeling of being exhausted after exercise in the past with negative affectivity. In contrast, 'Ellen', who reported getting a "kick" out of pushing herself hard, had recent experience of cycling (to university) and a general attitude that exercise is enjoyable. One explanation for these observations could simply be that recent inexperience and lack of familiarity with the sensations associated with exercise could contribute to the perception of relatively low-intensity exercise as negative. This is illustrated by 'Melanie's' comment that "I don't know if 'positive' is the right word to use or if 'negative' [is] the right word to use - it's just a different state when you're exercising". With regular exercise she would arguably become more familiar with that 'state' and assign an emotional value, or valence, to it.

Of course, these links between affective responses during acute exercise and the individual's exercise identity, attitude and history, are made with caution. The creation of these profiles required incorporation of the attitudes and histories of more than one individual, and so the relevance of these socio-psychological factors may appear accentuated because of that. In addition, the small sample size prevents inference of any firm conclusions, and there remains the possibility that these apparent links are coincidental. However, previous research points to the importance of one's self-identity in chronic physical activity behaviour (e.g., Anderson & Cychosz, 1995; Strachan, Woodgate, Brawley & Tse, 2005). This evidence, along with the qualitative reports in the present study, advocate the need for quantitative, experimental investigation of the relationship between affect *during* exercise and individual differences in exercise history, attitude and identity.

Finally, all three profiles made reference to a feeling of increased alertness and positivity after recovery, even though their experiences during both the IET and recovery differed substantially. This response was in keeping with the findings of study one, and indicated that the achievement of a state of positive affect (whether high- or low-activated) accurately describes the affective change that occurs from pre- to post-high-intensity exercise. Affective responses during exercise, however, appeared to be the consequence of a complex mix of cognitive, perceptual and emotional responses to physical and psychological stimuli that were largely, yet not solely, dependent upon exercise intensity. Clearly, additional inductive investigations are necessary in order to clarify the causes of idiosyncratic positive responses to high intensity exercise, such as those experienced by 'Ellen', and negative responses to relatively moderate intensity exercise, such as those experienced by 'Melanie'. Identification of the factors responsible could have important implications for the development of exercise promotion and prescription guidelines.

Part 2: Reflections of the known vs. unknown duration exercise experiences.

❑ **Profile 2A: Fran's aversion towards the Unknown Duration condition**

"I really internalised how I felt...I had nothing else to think about!"

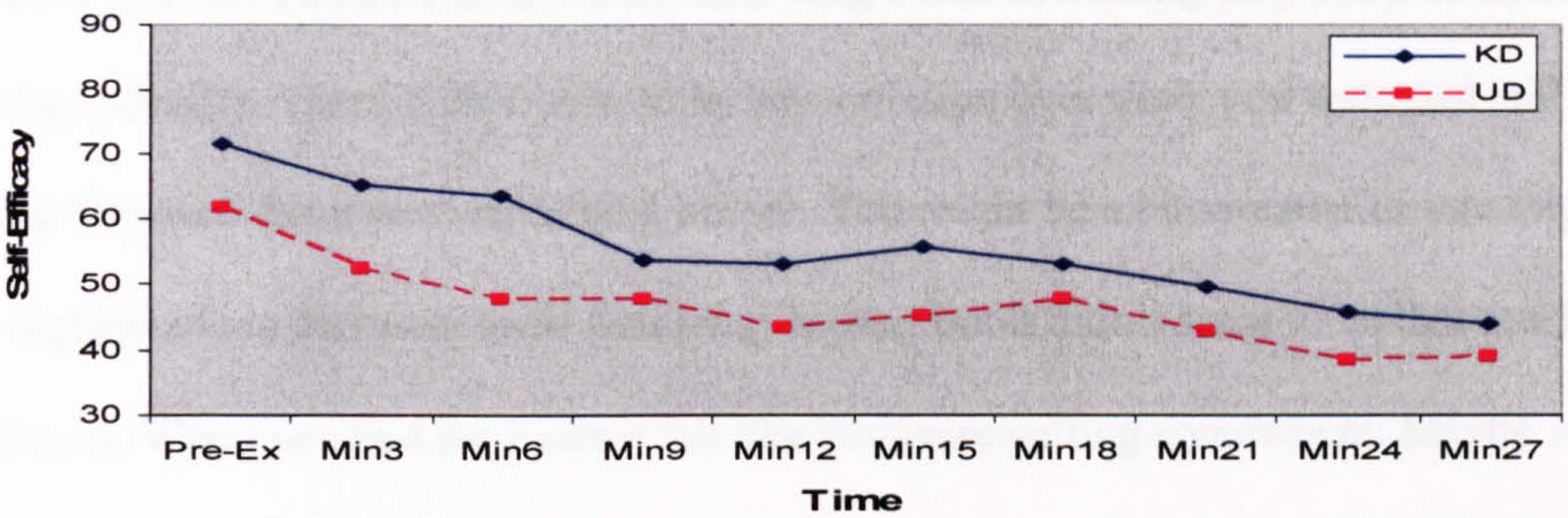
Table 6.4. **Descriptive Statistics of the participants that contributed to 'Fran's' profile.**

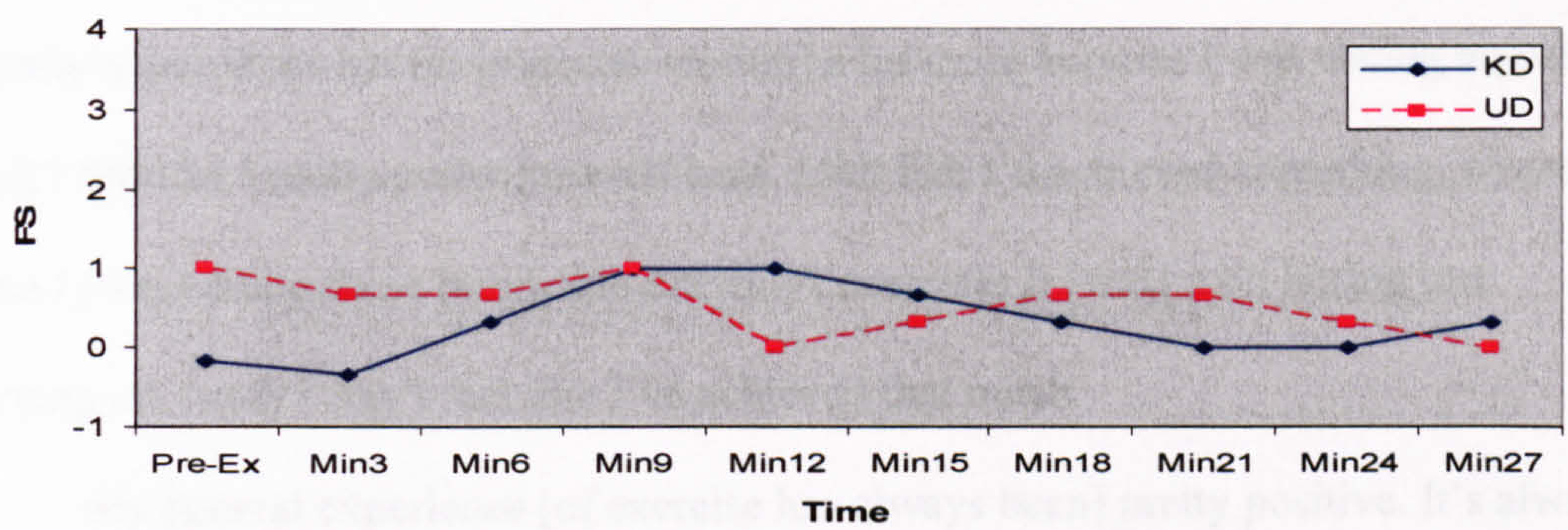
Participant	**A**	**E**	**C**
Age (yrs)	28	21	21
BMI	18.5	21.5	26.9
VO2peak (ml.kg.min^{-1})	40.98	39.00	27.45
VT (ml.kg.min^{-1}; as % of VO2peak)	19.67 (48%)	24.18 (62%)	14.00 (51%)
Workload 90% VT (W)	60	102	50

"They completely differed in every way! The [exercise bout] without the timing was really abstract because I didn't know how long it was. The fact that it was so abstract meant that I really internalised how I felt [and] I thought deeply about how I was feeling the whole time. I had nothing else to think about! It [also] seemed a lot longer [than the one with the clock]. I was feeling pretty uncomfortable, and I was [wondering] 'have I only actually cycled for 2 minutes or has it been an hour?!' I was [also] less confident [without knowledge of the duration]. [It] wasn't that I felt more tired and I was never breathing really heavily, or anything, but [whenever you asked me about my confidence] I wasn't so confident I could do it for longer. I lost all perception of time and I thought that the gaps between you asking me questions were probably quite long. Every time you came over and [asked] me the questions I was thinking 'let this be the end, let this be the end'! [When] you came to ask me the last few times I thought I was about to die! I felt there was no way that I would be able to cycle for another 20 minutes, because as far as I was concerned I might have already cycled for an hour. [Yet, because] I didn't have any idea how long I'd been cycling for and how long I would have to carry on, I think I was [also] daydreaming a bit more; it was less associative.

When [I] had the timer I was trying not to look at the clock because when I did it was going really slowly, but I was feeling quite good [and] I think [that being aware of the time] helped. I was exerting myself, sweating and stuff, so it wasn't really easy but I knew I could do it in my mind. It's sort of mind over matter, and with the clock [there] you can get a real feel for where you are. I spent a lot of time watching the clock and the rev counter, [and so] when I could see how long I'd gone [for] I was a lot more confident about how much [more] I could do. I could see 'I've done 20 minutes [and] that wasn't too bad', [and] I was [thinking] 'yes, I can do this', even [when] I felt really bad. Even though I [was] in a bit of a bad mood and I didn't really want to do it, I knew it was just going to be 30 minutes, whereas the other one just seemed [to take] ages [to finish]!

***Figure 6.7.* Self-efficacy and Affective Valence of 'Fran' throughout two 30 min exercise bouts at 90%VT.**





I don't think there was actually anything physically different [between the two experiences], I think it was psychological. I felt like I was achieving something [with the clock there]; it gave you something to aim towards [and] if you've got something to push against you feel like you're making progress. In my mind I thought, 'right I'm just going to do 30 minutes; I've got to push myself for that distance - that time'. If you'd put 30 minutes on the clock and I'd done that, and then you'd said 'actually I'm going to leave it going for another 30' I would have found it a lot harder to do another 30 minutes on top of that! When you don't know [the duration of the exercise] you're not actually mentally setting yourself a target because you just have to keep going and going… and going! [In that situation all you're thinking is] 'Yes, I'm still cycling, I was still cycling 10 minutes ago, [and] I'll probably still be cycling in another 10 minutes!' [Plus], if you're busy time goes faster! If you're just staring at a wall then time is going to take ages [to pass], [but with the clock] I had something to look at. If I'd had a TV programme or something to watch I think it would have gone faster as well.

I'm not sure either [exercise bout] was particularly pleasurable! But I don't think there were any particularly negative feelings [either] - I think they were all fairly neutral. The one [where I didn't know how long I was exercising for] was a bit more boring, actually. There didn't seem to be any variation over time, you were just still doing the same thing you were doing before. You might be a bit sweatier or you might be slightly aware that your heart [rate] was higher, but it didn't seem to be that much different. When you had the timer it felt like you were getting somewhere. Maybe 'boring' is the wrong word, [but] I wouldn't say I particularly enjoyed either of them. I actually enjoyed the harder [exercise session] a lot more because I was testing myself [and] I felt like I really pushed myself hard. I felt like I'd achieved something, whereas when I [was] doing these [moderate intensity] exercises it [was] a bit boring just carrying on, [and] I don't feel like I've achieved that much.

My general experience [of exercise has always been] pretty positive. It's always made me feel really good afterwards mentally, [and] I can build muscle quite quickly, so I like the effect it has on me physically over a relatively short period of time. When I was younger I did a lot [of activities, and] it was [a] really good [experience]. From the age of 5 I started dancing, which lots of girls do. I did ballet, jazz, tap, modern – you name it, I did it! I did that to the age of 16 [and] I also did horse riding from the age of 5 to 18. When I was about 9 or 10 I started trampolining, in addition to the other stuff. I was a national trampolinist, so I used to train for about 20 hours a week! I did that to the age of 15 and I went running as well. [Plus] I played netball and all the school team sports. Sometimes I knew people didn't want me on the team, they wanted one of their mates, [but] I had a lot of confidence in my ability in sport. [I thought] 'I'm in here for a reason', and so [being picked for teams] was a really good psychological boost. Yeah, I was pretty active [in my youth], [and] then at university I pretty much retired from physical activity! I used to go to aerobics once or twice a week, and I played hockey and volleyball for the university department team, but that wasn't serious.

When I started my PhD I got fitter again, actually. I did circuit training and 'step' *a lot*! I managed to maintain that level of activity [throughout my PhD, but] since coming to Leeds (for the last year) I haven't got my arse in gear at all and I've done next to nothing! I've been really busy working, so when I first arrived I found it quite hard to find the time to go and do something. I tried coming to an exercise class at the university, [but] it was really rubbish - I didn't even break a sweat despite the fact that I wasn't very fit! So I did try, but nothing really worked out. I find it genuinely very frustrating thinking that I'm unfit because I do enjoy physical activity; even when it's really painful and I hate it I still get quite a lot out of it.

- **Profile 2B: Justine's aversion towards the Known Duration condition.**

"It was more mentally painful – I felt like I had to focus and concentrate a lot more."

Table 6.5. **Descriptive Statistics of the participants that contributed to 'Justine's' profile.**

Participant	F	D	B
Age (yrs)	23	19	25
BMI	23.8	23.9	20.5
VO2peak (ml.kg.min^{-1})	32.57	25.51	31.98
VT (ml.kg.min^{-1}; as % of VO2peak)	16.29 (50%)	13.01 (51%)	16.63 (52%)
Workload 90% VT (W)	50	36	59

"Having the timer there was pretty hellish compared to not having it there. I really noticed it, to the extent where I went home and talked about it! Knowing how much longer you've got left changes how you feel. Physically, I knew I could do it, [but] when I wasn't watching the clock I found that I wasn't worrying about [doing] it and I was just getting on with it. When [I was] watching the clock I wasn't thinking 'ooh, that's another 5 minutes done', I was thinking, 'I've still got however long to go and it's not going very fast'. What's the saying? A clock never moves when you look at it. It was like I had this set task that I had to achieve, and it was much more like a chore. I was thinking about the time and then that made me in turn think about the exercise more, how long I had left and how long my cool-down was. If I felt tired at that point I thought, 'oh god, I've still got 20 minutes left'. [So] when I [knew I] had 20 minutes left I enjoyed it less because it felt like I had the majority of the test left. I [found] the pace quite challenging, too. I know it was moderate and I wasn't going uphill or anything like that, but I was aware that [I was] exercising. I was concentrating on my breathing, I was sweating, and I had pins and needles in my feet. I was thinking 'hurry up and finish because I'm not going to be able to reach 30 minutes'. I was constantly aware of motivating myself. I thought, 'right, to get through it I'll [try] not [to] think about what I'm doing: What am I going to have for lunch? What am I going to do later on? What's going on in the world?' But every time I tried to do that I found it even harder, so in the end [I just thought] 'I'll just concentrate on getting through it'.

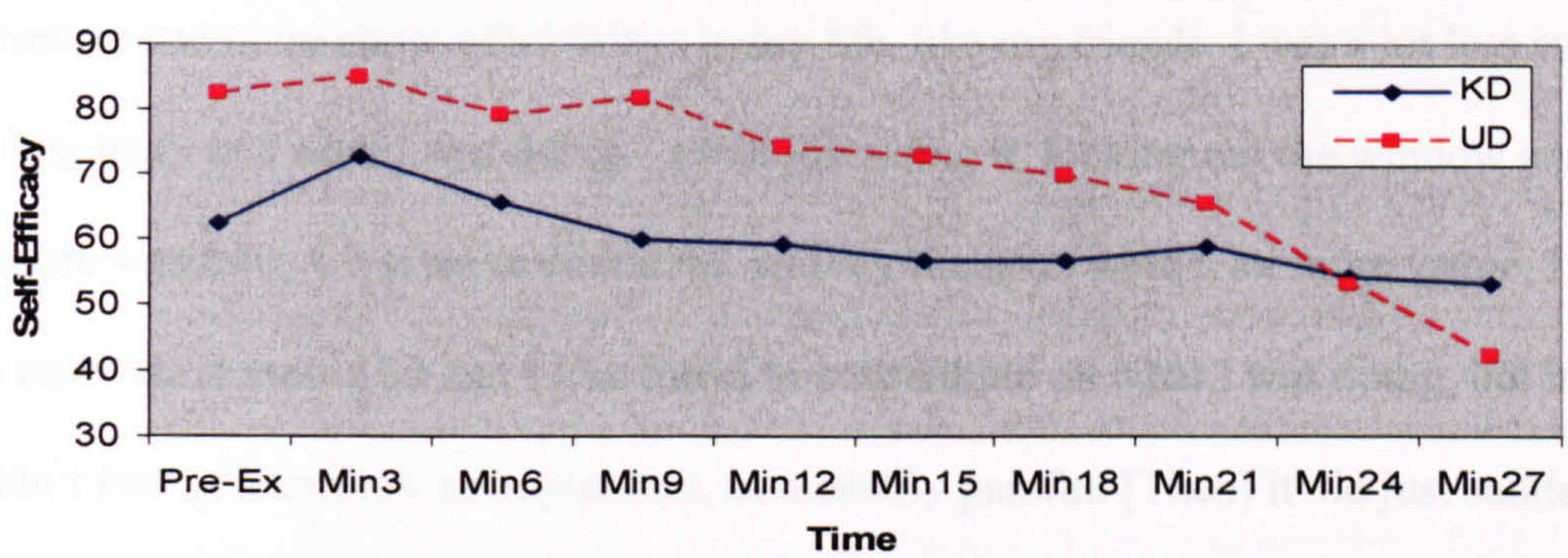
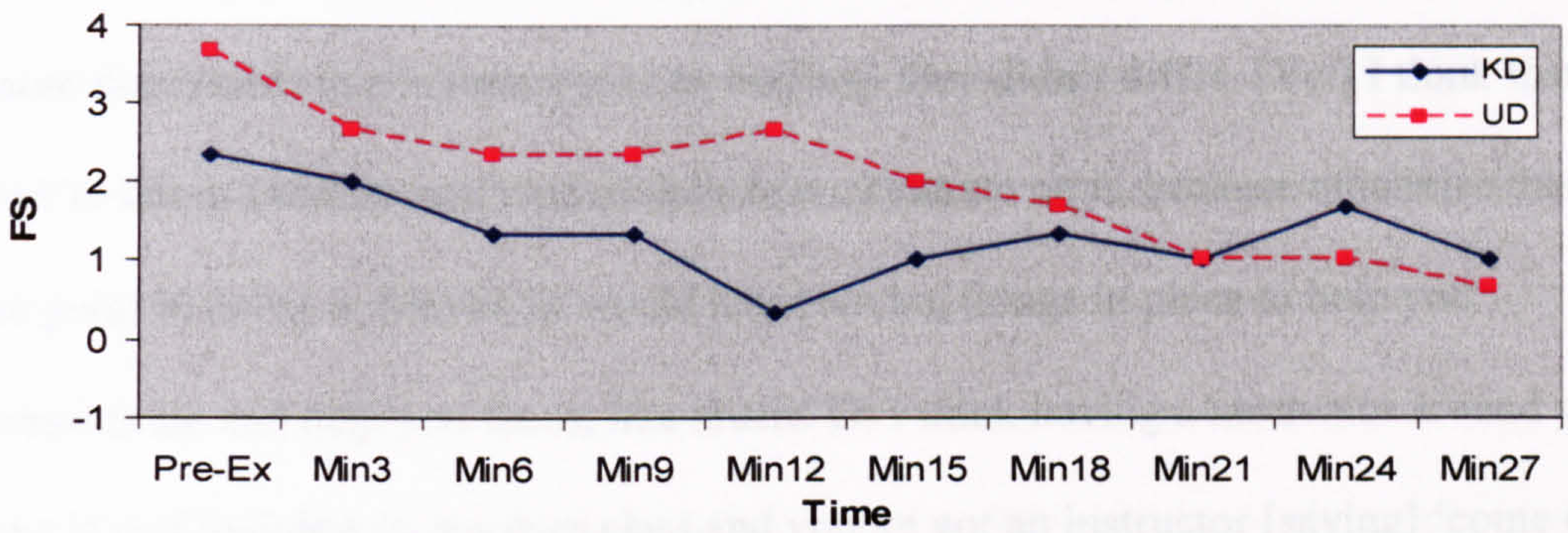


***Figure 6.8.* Self-efficacy of 'Justine' throughout two 30 min exercise bouts at 90%VT.**

The enjoyment factor seemed to be more of an issue [too], like [it is when I'm] studying. If I know I've got an hour to do then I'll be clock-watching a bit more and it's always a lot harder. It was quite striking that with the timer there it was more mentally painful – I felt like I had to focus and concentrate a lot more. But when I [only] had 5 minutes left it was easier persuading myself to carry on, [and] so towards the end I was more reassured that I'd be able to do it. I suppose I [was] thinking about it as if 30 minutes was some sort of maximum I could do, and so I was expecting it to get difficult by 30 minutes and for that to be my limit. [Having] the [time] limit sort of made it feel like it [was] a physical limit.

***Figure 6.9.* Affective Valence of 'Justine' throughout two 30 min exercise bouts at 90%VT.**



When there was no timer, for all I knew it could have been 2 hours before it [was] really [going to start to] become difficult! It [just] felt like it was a task [that] I had to do and [so] I'd just stop when and if I needed to, but [that I'd probably] just carry on until the end. [So] I just thought about different things – not [so] much about [the] exercise and more about other things in my life, like my friends. I was a lot less aware of my body and what I was doing – I was just doing it, looking out the window and people watching. I was quite distracted, and my thoughts were a lot more vague. I had to motivate myself a bit and I [did have] to concentrate on what I was doing, but it didn't feel as laborious, as unpleasant, as mentally painful. [Then] it did just suddenly get to a point where it went from being easy to not being easy. You start to feel hot, and you start to see the end rather than thinking you can just keep going on forever. [Without the timer] I think it was probably at about 15 [or] 20 minutes [when] that started, [but] with the timer [it was] possibly a bit earlier on.

When you first [told me] 'you're going to sit on a bike and exercise for 30 minutes', I felt a bit daunted. I don't think I've ever done that [before]. If I've gone to a gym [in the past, I've spent about] 10 minutes on different equipment. So the thought of [doing] 30 minutes [straight] was a bit of a daunting task. When I did it I felt more confident physically, and probably mentally. I've found [it] really beneficial to do something like this just to show me 'you can go at this intensity for a length of time'. [But] I felt quite bored in both of them, [you're] just sitting on the bike [and] there are no distractions, no music. In both sessions I was wishing I was outside cycling much more than inside in a laboratory, so in that way they didn't differ. [Yet] I think that if you're doing exercise you kind of *have* to concentrate on it, because otherwise there's no point in doing it. Maybe [it would help] having things in place to help you concentrate and help you focus, like music. Or I think having a motivator around you, like if you're doing an aerobics class and you've got an instructor [saying] 'come on, you can do it, keep on going'. [But] I don't think that it would help me to be in a really exercise-focused situation where I was only there for the exercise. I can think of people who very much love exercise and spend an hour in the gym solely focusing on exercise, and that's their aim. And that's fine, we all have our things that get us going, but that does nothing for me.

[In fact, I] joined a gym in my second year [at university, and] I didn't really like the experience. I had a [weekly] personal trainer session and a personal fitness plan. It was very physically-oriented; it was all about going to the gym and doing [a] three-quarters-of-an-hour workout to gain physical strength [and] lose weight, which for me just wasn't really a good thing. I think if you've got a remotely obsessive personality you just end up sitting on these machines [and] you start to compete against the machine - you're clock watching. I suppose that's where [the fact that] I really don't like looking at [the] time when exercising [comes from], because it just was not enjoyable to sit on a rowing machine in this gym for 10 minutes, waiting for the time to end. Also, I didn't think I needed to lose weight [so] I didn't particularly look good, I didn't feel better physically, and I think it would have just been nicer to take a much more gentle approach. I haven't been really tired following these sessions, but I know that when I went to the gym before I just felt knackered. I felt really tired and foggy for the rest of the day, so that wasn't particularly enjoyable. I hate the fact that there are mirrors in the gym, [too,] because I don't want to see myself when I'm sweating, running and everything's bouncing around! I do enjoy outdoor activities, but mainly when it's warm; in the winter I'm very inactive, I just don't like going outside!

[When I was younger] I did curriculum sport at school as everybody has to and I did have a few bouts of [other] exercise. There was one time when I was about 14; I decided that I wanted to be a bit fitter so I had a go at running. It was a bit weird, but I think I felt that sport wasn't an area where I was really achieving so I thought 'right, do some running'. I trained for a period of months and did well in sports day that year, so that was nice! But I didn't compete. They wanted me to compete [on the school team] and I didn't really feel happy about competing. I felt like I was doing something for myself. I wanted to be a bit more active and I wanted to achieve something, but that was for me, it wasn't for the school [and] it wasn't necessarily to feel better physically than other people.

I think that your early experiences of sport do affect you, and I think that there's [a] tendency to put labels on ourselves. [My friends and I] were talking about this [at] the weekend. My friend said, "At school I felt like I [wasn't] sporty because I couldn't compete [and] I was never picked for the teams". He [said], "it's ridiculous: I'm healthy, I'm fit, and I left school and joined a gym. I could always have done [that] but I never felt the confidence to do [it]". I suppose that 5 years ago I think I would have thought I'm not a 'sporty type'. Now I think it's really ridiculous for me to say that sort of thing when I know I can sit on a bike and cycle for 30 minutes - and I walk everywhere, I don't get buses. The thing that I feel now is that I can have a healthy lifestyle and I don't need to worry about being sporty or not. You can have a 'halfway' where you are doing exercise [regularly] but you don't have to feel inadequate because sport isn't your life. [Actually,] I've joined a gym now and I feel much more confident in what I feel I can do [and] the way that I'm going to go about it as well; I'm not going to set myself timers! I might set myself a stopwatch or something to beep at me when I've done 20 minutes, but that's it!"

Discussion of Part 2: Reflections of the known vs. unknown duration exercise experiences.

Overall, both 'Fran' and 'Justine' clearly perceived the two 30-minute 'moderate' intensity exercise bouts as significantly different from one another. Interestingly, however, neither of the narratives indicated that their overall experience of either exercise bout was particularly pleasant or unpleasant, but that one was just more bearable than the other. Both also referred to an ability to dissociate from analysis of the task demands more easily in their 'preferred' exercise bout, which helped them to endure the exercise.

'Fran' described the challenges she experienced in the UD condition as more "psychological" than "physical", which is consistent with the notion that cognitive appraisal factors are key to affective perceptions at this intensity (Ekkekakis et al., 2005a). Notably, it appears that having a timer seemed to facilitate her perceptions of self-efficacy. She reported that watching the clock tick directly contributed to her sense of achievement and, apparently, her level of affect. For example, she reported that "I could see 'I've done 20 minutes [and] that wasn't too bad', [and] I was [thinking] 'yes, I can do this'." With cognitive appraisal of the task being the apparent driving force behind affect at this intensity, 'Fran's' observations could help to explain the mean patterns of affective valence that were observed in study three. Without the timer there her progression, and therefore her sense of achievement, was more ambiguous. In addition, the absence of a sense of time corresponded with reports that her attention and feelings became more "internalised" (or associative), which may have contributed to a more challenging experience. 'Justine', on the other hand, reported that when she was clock-watching she was more worried about being able to do the exercise and perceived it as more of a chore. Comparatively, when she did not have a clock she commented that she was able to get "lost" (i.e., be less aware of her body and what she was doing). Arguably, she appeared to derive more pleasure and a sense of achievement from being absorbed in the task itself when there was no clock ticking in front of her.

Further support in favour of the influence of self-efficacy perceptions upon affective responses during exercise was exposed by 'Justine', who's identification of factors that she perceived to underlie these perceptions provide evidence of the abundant sources of self-efficacy attended to during exercise. She indicated that her dislike of the KD condition may be explained by her association of clock-watching during exercise with previous negative exercise experiences. This observation strengthens the notion that previous experiences could contribute acutely to exercise-induced affect. In addition, she suggested that the importance placed upon success and achievement in school sport, and the consequential perception of oneself as 'sporty' or not, influences one's confidence in their exercise capabilities. For example, she commented, "I suppose that 5 years ago I think I would have thought I'm not a 'sporty type'. Now I think it's really ridiculous for me to say that sort of thing when I know I can sit on a bike and cycle for 30 minutes..." This is an interesting perspective, and suggests that the sense of exercise identity one develops at school can influence self-efficacy for exercise during adulthood. Previous research shows that the school sport experience helps to shape young females' sense of physical competence and physical identity (Garrett, 2004), and that sport identity was a strong predictor of participation in sport amongst secondary-school age children (Lau, Fox & Cheung, 2004). There is reason to suggest that the sense of athletic identity developed during one's youth has potential to influence beliefs about one's physical capabilities and actual exercise participation during adulthood. This observation is particularly important when the particularly low levels of physical activity participation amongst female adults in the UK (Sport England, 2006; Department of Health, 2004) are considered. It also provides further justification for the investigation of physical activity history, attitudes and exercise identity in relation to affective responses to exercise.

Probably the most consistent word used to describe the overall experience of both exercise bouts was the adjective "boring"! Both profiles indicated that distractions or more pleasant situational factors would have made the experience more pleasant. It appears that something as simple as the exercise situation may have contributed substantially to participants' negative perceptions of the exercise experiences, and that continual moderate intensity exercise alone is unlikely to induce positive during-exercise affect. This is consistent with research that shows more positive affect when, for example, participants have music to listen to (e.g., Elliott, Carr & Orme, 2005) or exercise outside compared to in a laboratory (e.g., LaCaille et al., 2004). The laboratory location was necessary in the present study for preservation of a controlled experimental environment. However, these observations suggest that 'moderate' intensity exercise needs to be accompanied by appropriate environmental and external stimuli to encourage a positive experience.

General Discussion and Conclusions

The purpose of this investigation was to create individual profiles from quantitative data and interviews with study participants that represented the range and variability in the affective exercise experience – both throughout incremental exercise to volitional exhaustion (Part 1) and in response to 'moderate' intensity exercise bouts where perception of exercise duration was manipulated (Part 2). The resulting profiles captured the complex changeable relationships between perceptions, cognitions and affect that low-active females experienced during these two tasks.

The profiles in Part 1 depicted that appraisal of social-cognitive and task related factors became more difficult as exercise intensity increased and sensations of physiological stimuli appeared to take over, in accordance with the dual-mode model. However, these profiles also provide evidence that perceptions of the physiological cues at high intensity did not hold negative connotations in all cases and were not necessarily at the forefront of the affective experience during high intensity exercise. The profiles depicted in Part 2 reinforce the notion that was identified in study three: that cognitive appraisal was a constant process during steady-state exercise and directly influenced the valence attached to the experience. Also emphasised in part 2 was that external stimuli (e.g., music, environmental preferences) present during exercise could improve the chance that 'moderate' intensity exercise induces a positive affective experience in previously sedentary female exercisers.

Overall, few generalisable conclusions can be drawn from the profiles depicted in this study due to a small sample size and the atypical methodology. Nonetheless, a number of observations were made that provide rationale for particular focal points for research and application in the future. In particular, this study reinforced the notion of a relationship between self-efficacy and affect during exercise, and a number of seemingly important during-exercise self-efficacy sources were documented. In particular, there were many varied examples of how perceptions of exertion during exercise appeared to influence the relationship between self-efficacy and affect during exercise - particularly during the incremental exercise test. For example, 'Jen' stated that "Physically my muscles were aching, but that made me feel quite good because I knew that I was working my body and tiring it out". This was in contrast to 'Melanie's' observation that "I [was] lethargic and a bit frustrated: it was really dawning on me that this was going to be hard and maybe I'm not going to be able to continue." These observations provide evidence of Bandura's (1997) contention that the extent to which people alter their efficacy through performance experiences depends not only upon preconceptions of capability, but also upon perceived task difficulty and effort.

Evidence of the influence of performance experiences upon the self-efficacy/affect relationship during exercise was abundant – especially when participants were asked to compare the known and unknown duration conditions. One example from 'Fran' was that during the known duration condition she "could see 'I've done 20 minutes [and] that wasn't too bad', [and] I was [thinking] 'yes, I can do this'.". In the unknown duration condition, however, she "was [wondering] 'have I only actually cycled for 2 minutes or has it been an hour?! I was less confident..." The former quote from 'Fran's' profile was also a good example of how verbal persuasion (another important source of self-efficacy, according to Bandura, 1997) appeared to play a key role in efficacy/affect relationship during exercise. 'Fran' used the observation of elapsed time to enforce a sense of achievement and reinforce her belief in her capabilities ("yes, I can do this"). In contrast, 'Justine's' profile provided evidence of how the interpretation of elapsed time may negatively influence efficacy beliefs through negative verbal persuasion: "When [I was] watching the clock I wasn't thinking 'ooh, that's another 5 minutes done', I was thinking, 'I've still got however long to go and it's not going very fast'."

Documentation of these specific sources enables practitioners and individuals to move forward with the development of specific intervention strategies that can be administered during exercise, which are aimed at improving exercise-related self-efficacy perceptions during the adoption phase of physical activity programmes. There is also evidence in this study to suggest that one's exercise identity, attitudes and activity history could have an impact upon exercise-induced affective responses. This relationship may be direct or mediated through the self-efficacy/affect relationship. These specific social and cognitive appraisal factors are potentially important avenues for future experimental research. In conclusion, this research indicates that the affective experience of acute exercise amongst low-active females is somewhat intensity-dependent, but that cognitive, perceptual and environmental factors appear to impinge on the intensity-affect relationship in a more complex way than is suggested by current theoretical models (e.g., the dual-mode model; Ekkekakis et al., 2005a).

Chapter Seven: General Discussion

The overall objective of the research presented in this thesis was to investigate the role of cognitive appraisal upon variability in affective responses to exercise amongst low-active women. The recently proposed 'dual-mode model' (Ekkekakis, 2003; Ekkekakis et al., 2005a) provided the theoretical framework for this research, the main tenet of which is the notion that changes in affect during exercise are the result of the continual interplay between physiological and cognitive cues. Specifically, the model suggests that the relative influence of these factors varies as a function of exercise intensity. Below the ventilatory threshold (VT; i.e. the 'moderate' intensity domain) affective responses are posited to be homogenously positive, with a low to moderate influence of cognitive appraisal factors. Within the 'heavy' intensity range (at and just above VT), affective responses during exercise are theorised to be strongly susceptible to the influence of cognitive factors and, as a result, interindividual variance is likely. At much higher exercise intensities (i.e., above the level of critical power; termed the 'severe' intensity domain) physiological or 'interoceptive' cues are theorised to dominate, the result of which is a mean 'displeasure' response. Finally, the model purports that upon cessation of exercise, affective responses will be more positive than before exercise – irrespective of affect levels during exercise or exercise intensity.

Although this model has found support in the neuroscience literature and experimental research with fit, healthy athletes (cf. Ekkekakis et al., 2005a); there has been little evidence to suggest that the model would hold true with habitually low-active women. Considering the current guidelines promoting regular 'moderate' intensity exercise, of particular interest was the notion that cognitive appraisal factors may govern affective responses around the VT. Attentional focus (studies two and three) and self-efficacy (study three) were identified as specific cognitive appraisal factors that have received previous interest in the exercise-affect literature and deserved further investigation amongst low-active women from a dual-mode perspective. Four studies were conducted in this thesis to provide a detailed investigation interindividual variability and the influence of cognitive appraisal upon affective responses during and after exercise amongst habitually low-active women.

Study 1 findings

The first investigation was a pilot study that involved the re-analysis of previously collected data (Welch, 2001) designed to explore the variability of affective responses of both inactive and active females to high and low intensity exercise. Exploratory analyses revealed variability in the direction of affective responses from pre- to mid-exercise similar to that observed by Van Landuyt et al. (2000). In addition, a much broader range of FS scores (including negative values) were reported by inactive participants during exercise in both conditions than those reported by active participants. This could be indicative of greater interindividual variability across exercise intensities within an inactive sample than that suggested by Ekkekakis' (2003) dual-mode model. It was concluded that direct investigation of this notion is clearly warranted if the mechanisms underlying affective responses to exercise are to be fully understood.

This study also highlighted the difficulty in drawing conclusions in research with design flaws that are common to a number of previous investigations in this area. Thus, the importance of sound methodological control of exercise intensity (using metabolic demarcators), the use both activation and valence dimensions to measure affect, and the inclusion of repeated measurements of affect during exercise were identified as important methodological concerns for the subsequent investigations in this thesis.

Study 2 findings

This study was designed specifically to investigate the tenets of the dual-mode model within a low-active female sample. Affective responses were measured before, throughout and after an incremental exercise test (IET) to volitional exhaustion. Attentional focus was also measured throughout exercise. Results indicated that participants were significantly more activated immediately after exercise in comparison to pre-exercise, and that affective valence was significantly more positive after exercise in comparison to pre-exercise (although this shift to positivity was somewhat delayed). However, during exercise there was a progressive increase in activation and progressive decline in affective valence until volitional exhaustion. Attentional focus also became more associative as intensity increased, indicating greater attention on the exercise and potentially reflecting a greater influence of interoceptive cues. These results were consistent with dual-mode theorising.

However, contrary to suggestions of the dual-mode model, mean affective valence during exercise declined before VT was reached. Closer inspection of the data revealed that there was evidence of interindividual variability in *directional* affective valence changes below VT, and that the *magnitude* of valence change was subject to widespread variability towards the end of the IET. These findings indicated that affective responses during exercise were subject to variability in direction and magnitude across exercise intensities. The mean decline in valence below VT was in contrast to previous research (Parfitt et al., 2006; Hall et al., 2002; Bixby et al., 2001), yet the variability observed within this intensity domain was consistent with Parfitt et al. (2006), whose study also involved low-active participants. These results suggest that cognitive appraisal factors may be a stronger influence upon affective responses below the VT than suggested by the dual-mode model.

Study 3 findings

In order to further explore the role of cognitive appraisal as a mechanism underlying affect responses during exercise at an intensity proximal to the VT, low-active females' perception of exercise duration was manipulated in study three. Specifically, participants engaged in two 30-min exercise bouts at 90% VT on separate days, during which affective responses were measured repeatedly. The only difference between the conditions was that in one exercise duration was known (KD), and in the other condition exercise duration was unknown (UD). Self-efficacy, attentional focus and perceived exertion were also measured repeatedly throughout both exercise bouts. Results indicated pre- to post-exercise improvements in affect in both conditions. During exercise, however, findings revealed that perceptions of exertion, affective valence and self-efficacy perceptions were all significantly lower towards the end of the UD exercise bout in comparison to the KD bout. Specifically, affective responses in both exercise bouts appeared to decline similarly during the first half of exercise, and then reached a plateau in the KD condition but continued to decline in the UD condition. The observation that affective responses were susceptible to cognitive manipulation during exercise at an intensity that approximated VT provided support for the notion that cognitive appraisal influences affective responses during 'moderate' to 'heavy' intensity exercise.

Further analyses revealed that pre-exercise self-efficacy only predicted variance in affect towards the end of the UD condition. However, self-efficacy measured during exercise predicted variance in affect halfway through the UD condition and towards the end of both conditions, above and beyond that explained by pre-exercise self-efficacy perceptions. These findings indicated that individuals who experience low self-efficacy during exercise were more likely to respond negatively during the exercise bout, particularly towards the end of exercise, and when the exercise task was ambiguous and perceptions of exertion were higher. The results also suggested that, within a low-active female sample, self-efficacy measured during exercise was a better predictor of affective variance during exercise than the traditional method of measuring self-efficacy before exercise.

Study 4 findings

The final study was designed to explore in detail the nature of individual variability in affective responses and the underlying cognitive and perceptual processes. In order to meet this objective five narrative profiles were crafted that were based upon interviews with participants, and these narratives were paired with quantitative descriptive statistics and psychometric responses. Specifically, the profiles explored, (1) a range of during-exercise IET experiences (three profiles; i.e., valence decline at VT, valence decline above VT and no valence decline), and (2) opposing experiences of the known and unknown duration exercise bouts (two profiles; one with preference for the KD, one with preference for the UD). These profiles provided insight into the range of exercise experiences of low-active females and, specifically, the interactive nature of the perceptual, cognitive and affective processes that defined the experiences.

In particular, within all three IET profiles references to dual-influences upon affective responses were conveyed, suggesting that cognitive appraisal of both self and the task were influential from the moment exercise began, and that interoceptive sensations appeared to contribute to attentional focus and affect towards the end of the IET. However, the perception of these sensations as negative appeared to vary across individuals. All of the profiles also included annotations to support the notion that self-efficacy perceptions during exercise were related to affective responses, with suggestions of specific and varied sources of self-efficacy communicated. Other social and cognitive appraisal factors that may influence the exercise experience at lower intensities (e.g., social physique anxiety, physical activity history, exercise identity, and attitudes towards exercise) also emerged from these profiles.

Theoretical contributions of the research

The results of this research have been discussed in the context of the dual-mode model (Ekkekakis, 2003; Ekkekakis et al., 2005a) throughout this thesis. It can be concluded that findings broadly support this theory in that they provide evidence for pre-post improvements in affect, irrespective of exercise intensity. Findings also support the notion of progressive increases in activation and declines in affective valence during exercise as intensity increases. In addition, attentional focus data and qualitative reports were supportive of the suggestion that there is a continual interplay between cognitive and physiological cues that varies as a function of exercise intensity. The results of study three also provided strong support for the notion that cognitive appraisal factors govern affective responses at intensities proximal to VT, and specifically that self-efficacy perceptions may play an important role in driving affect at this intensity. However, quantitative and qualitative data indicated that, within an low-active female sample, cognitive appraisal factors may be a stronger influence upon variability in affective responses at exercise intensities below the VT than is suggested by the dual-mode model. Results also indicated that the magnitude, as well as the direction, of affective responses may be an important contributor to the affective experiences of low-active women during high intensity exercise.

Considering that the participants involved in this research (i.e., low-active women) are representative of a large section of the population (i.e., 82% of the female population in England are estimated to be inactive; Sport England, 2006), tentative recommendations can be made to suggest that the dual-mode model should be revised to encompass the findings of the present research. Specifically, the observation of variability in affective valence below the VT provides evidence against homogeneity at this intensity. Instead, these results indicate that there is variability and a strong influence of cognitive appraisal factors on affective responses during exercise both below and at VT. In addition, whilst the direction of affective responses does appear to be largely negative above VT, the magnitude of these responses is subject to considerable variability. It is therefore recommended that the term 'homogeneity' be disconnected from the dual-mode model to describe affective responses in the 'severe' intensity domain, especially as this research provided evidence that positive responses can be manifested at very high exercise intensity levels.

The discovery in study three that the decline in affective valence responses reached a plateau approximately mid-exercise when exercise duration was known, but continued to decline in the UD condition, can be explained by the concept of teleoanticipation. This concept was originally proposed by Ulmer (1996) and identified as a key factor in pacing strategies by St Clair Gibson et al (2006). They propose that this 'internal clock' mechanism works together with memory of prior events of similar distance or duration, and knowledge of external (environmental) and internal (metabolic) conditions to set a particular optimal pacing strategy for a particular exercise bout. Thus, lack of knowledge of exercise duration will directly impact upon ones ability to employ teleoanticipatory mechanisms successfully. Based upon results of the present study it can be proposed that teleoanticipation (or consideration of a finishing point) may not only regulate pacing and perceptions of exertion, but can also influence the changes in affective valence one experiences as exercise progresses; potentially due to the importance of the mechanism's interaction with previous experience (the primary source of self-efficacy). Indeed, this observation provides additional explanation for why more experienced exercisers (with the experience of cognitively 'pacing' themselves) appear more likely to respond positively to exercise in the moderate-heavy intensity domain (e.g., Hall et al., 2002; Bixby et al., 2001).

However, further direct investigation of this concept is warranted before the relevance of teleoanticipatory mechanisms at various exercise intensities (with respect to dual-mode theorising) can be identified and conclusions can be made.

Another important theoretical contribution of this research was the discovery that self-efficacy perceptions were susceptible to change during exercise, by manipulating knowledge of task duration, and were positively related to affective responses during exercise. These observations are consistent with self-efficacy theory (Bandura, 1997), which infers a causal relationship between self-efficacy and affect, and suggests that self-efficacy perceptions are dependent not only upon preconceptions of capability, but on perceived task difficulty and effort. This is an important finding for those concerned with the influence of the cognitive appraisal of self in relation to task demands. In addition, the profiles depicted in study four provide some support for progressive changes in self-efficacy perceptions during exercise as a result of altering the task demands. In future, researchers are encouraged to consider the impact that engagement in the exercise task can have upon perceptions of capability. Indeed, task engagement may act as a theoretically relevant moderator, and researchers may discover that under conditions of task engagement, a stronger relationship between self-efficacy and other psychological outcomes of exercise (e.g., stress or anxiety reduction) exists than has previously been identified (e.g., Katula, Blissmer & McAuley, 1999).

Lastly, from a theoretical standpoint it is important to consider the results of the present research in the context of hedonic theory. In particular, the observation that affective valence responses were lower at the end of continual 30 min 'moderate' intensity exercise bout of unknown duration in comparison to an exercise bout of known duration has significant theoretical implications according to the 'peak and end rule' (Fredrickson, 2000). This rule would suggest that the UD condition would have been perceived as more aversive upon reflection than the KD condition if affect was lower at the end of exercise, a notion that appears to be upheld by the reflections provided by the narrative profiles portrayed in the final study. However, potentially of more importance is the observation that affective valence was lower in both 30 min exercise bouts at the end of exercise in comparison to the beginning of exercise. According to the peak and end rule, this would diminish the likelihood that the behaviour would be repeated in the future. A reduction in intensity towards the end of the exercise bout may have resulted in an improved affective profile and, potentially, more positive reflections of the UD condition.

Practical implications and recommendations for interventions

The findings of this research hold a number of important implications for exercise prescription for previously low-active women. It appears that low-active women are likely to respond negatively to exercise when the intensity exceeds VT. However, for low-active females, a diminished affective experience at or below the VT is also likely when the task demands are ambiguous and self-efficacy perceptions are low. These are important considerations for anyone working with individuals to develop a physical activity programme, from cardiac rehabilitation specialists to personal trainers. Paying heed to the following recommendations can reduce the likelihood that the exercise experience is perceived as negative by previously low-active women, and, in turn, adherence to exercise programmes could be enhanced.

The amount and type of information that participants have about the exercise task directly influences their affective experience of that exercise. Therefore, during the initial phase of any exercise program for women, it is important to ensure that task demands are laid out clearly. Practitioners should also endeavour to ensure that the individual is confident about her ability to adhere to the task demands, and that this confidence is continually reinforced throughout the exercise bout. Based upon the qualitative reports in this thesis and previous research (e.g., Raedeke, Focht & Scales, 2007; Martin Ginis, Jung & Gauvin, 2003), it can also be suggested that the individual should exercise in an environment that is preferable for them, in which they feel comfortable, that any feelings of social anxiety are minimised, and that any external stimuli that the individual feels may aid their experience (e.g., music, timers, etc) are present. All of these factors should be attended to before the exercise intensity that is likely to induce positive affective responses can be identified. The majority of these factors can be addressed by engaging in discussion with the individual before the exercise programme is designed in order to reduce task ambiguity and establish these preferences, and by ensuring that the programme is individualised by actively involving them in its design.

An important factor that emerged from this research which requires additional attention from practitioners is the notion that the process of cognitive appraisal of the task and oneself was continual throughout exercise at ~VT, and that this was directly related to participants' affective responses. It is evident that strategies should be designed to enhance self-efficacy during the course of an exercise bout, which can be learnt, administered, and self-regulated by the individual. Specifically, some of the psychological skills used by athletes to promote self-confidence/self-efficacy during competition, such as self-talk could also be effective for enhancing efficacy in previously low-active people engaging in exercise.

Self-talk has been defined as individual's verbalisations that are addressed to themselves, which can serve both instructional and motivational functions (Hardy, Hall & Hardy, 2005). It has been well-documented in the sport psychology literature as a useful tool for improving confidence and affective states (e.g., Hardy, Hall & Alexander, 2001), and has recently been identified by regular exercisers as an important motivational and confidence-boosting strategy during exercise (Gammage, Hardy & Hall, 2001). However, no attention has been paid to during-exercise self-talk amongst low-active exercisers in past research. In fact, the narratives in study four provided evidence of some participants engaging in self-talk, specifically verbal persuasion (an important source of self-efficacy; Bandura, 1997), during exercise. For example, one participant noted "I could see 'I've done 20 minutes [and] that wasn't too bad', [and] I was [thinking] 'yes, I can do this'." Practitioners are encouraged to explore the self-talk literature to identify effective strategies (e.g., Hardy et al., 2005; Amsel & Fichten, 1998). Specifically, focus should be upon educating exercisers to use positive self-statements and to turn negative observations into positive ones whilst they exercise (e.g., change "I've only done 10 minutes" to "I've done 10 minutes – well done").

Limitations and Future Research Directions

In spite of the substantive theoretical, empirical, and applied contributions of the research in this thesis, it is important to identify potential methodological limitations of the present research that should be attended to in future research. Measurements of affect in these studies were not taken during either warm-up or cool down, and this may have provided a restricted view of affective changes that occurred from the onset of exercise and during recovery. For example, these omissions resulted in a limited view of the affective changes that occurred below the VT in study two, as did the fact that warm-up duration was not standardised. Future research that seeks to explore the full spectrum of the exercise experience should not overlook the importance of affective responses during warm-up and cool-down, particularly with relatively inactive samples where these intensities may still present an appreciable challenge to the participants. In addition, whilst this research demonstrated variability in the magnitude of affect at high exercise intensities, the relevance and source of this phenomenon remains unknown and warrants systematic investigation. In order to further test the dual-mode model, it is also important that future research investigate the role of cognitive appraisal upon affective responses by repeating study three at intensities both above and substantially below VT in active and inactive, male and female samples.

The present research was contemporary in that measurement of exercise intensity took into account individual metabolic differences. This method of defining intensity was an important contributor to the research findings as it effectively eradicated the possibility that individual differences were due to any differences in underlying metabolic mechanisms, as may have been the case with previous research that defined intensity as a percentage of maximal capacity. The findings are therefore directly comparable to previous research that has used similar methods of defining intensity (e.g., Hall et al., 2002; Bixby et al., 2001). However, an observation was made in study two that the identification of any differences in affect between 'heavy' and 'severe' exercise intensity (above and below critical power) was impossible to operationalise using the data available. It was also difficult to identify levels of affect at the exact point of VT as affect can not be measured at the same frequency as $\dot{V}O_2$ kinetics. These are concepts that Ekkekakis and Acevado (2006) recently took into account with respect to the dual-mode model. The terms 'moderate', 'heavy' and 'severe' intensity were replaced with more appropriate operational definitions of intensity domains, namely 'below…', 'proximal to…' and 'above the level of the aerobic-anaerobic transition'. It is therefore recommended that the researchers continue to use the dual-mode model as a theoretical framework for investigations into affective responses, but that the more practical terms suggested by Ekkekakis and Acevado (2006) be used to distinguish intensity domains.

It was demonstrated empirically in study three that self-efficacy responses contributed significantly to variances in affect during exercise at ~VT. However, an important theoretical consideration is the notion that a substantial amount of the variance in affect during exercise at the VT was *not* accounted for by self-efficacy perceptions. The challenge for researchers now is to systematically investigate other variables that may be responsible for this additional variance. A number of social-cognitive variables that have potential to mediate the exercise-affect relationship at the VT emerged from the qualitative profiles in study four. These included exercise history, exercise identity and attitudes towards exercise. A multitude of other variables have also been suggested by previous authors to influence affective responses to exercise, and include social physique anxiety and the social environment (e.g., Raedeke, et al, 2007), the physical environment (e.g., Martin Ginis et al., 2003), personality (e.g., Ekkekakis, Hall & Petruzzello, 2005b) and self-determination (Parfitt et al., 2006). These constructs warrant further investigation within the context of the dual-mode model to ascertain whether their influence is intensity dependent for low-active participants.

There is some evidence to suggest that genetic factors may also account for variance in acute psychological responses to exercise. According to a recent model proposed by Bryan, Hutchinson, Seals and Allen (2007), both genetic and physiological factors influence psychological outcomes of acute exercise, and these in turn influence future exercise behaviour. This model was based upon the identification that the brain-derived neurotrophic factor (BDNF) gene moderated the effect of acute exercise at 65% $\dot{V}O_2$ max on mood, heart rate and perceived exertion. In addition, mood response was a significant correlate of intention to exercise in the future and current exercise behaviour. Whilst these findings are encouraging, particularly from a hedonic theory perspective, it is important for future research to investigate the relationship between these factors at various exercise intensities relative to the VT. At present, the dual-mode model gives little consideration to the notion that genetic factors may play a role in the exercise-intensity/affect relationship. Therefore, it seems imperative to identify whether genetic factors have a varied influence upon affective responses across exercise intensities.

Due to the underpinning theoretical model (i.e., the dual-mode model; Ekkekakis, 2003), studies three and four of this thesis adopted the theoretical stance that the relationship between self-efficacy and affect was unidirectional. However, an important consideration for future research is the notion that, from the perspective of self-efficacy theory (Bandura, 1997), the relationship between self-efficacy and affect is considered reciprocal. It is possible that changes in self-efficacy that occur during an exercise bout may influence affective responses, which, in turn, impact upon efficacy beliefs, and that this interaction continues throughout acute exercise. This proposition is supported by research that has measured self-efficacy pre- to post-exercise (e.g., McAuley & Courneya, 1992), and clearly warrants further investigation with repeated measurements of both efficacy and affect during exercise bouts at intensities both below and above VT.

Arguably the most important step for future research to take is to investigate the relationship between cognitive appraisal factors (specifically self-efficacy) and affect longitudinally in the context of hedonic theory. There is little indication if or how these factors may change over the course of an exercise programme, and how or if they contribute to dropout. Some recent research has identified that there appears to be a relationship between affective states during exercise and exercise behaviour (Williams et al., in press; Annesi, 2005), yet these studies were correlational and, as a result, causality can not be supposed. The exercise-affect literature is also in need of intervention research that utilises the knowledge acquired in the present and previous research to manipulate participants' cognitive appraisal of self and the exercise tasks to induce positive affective responses. This experimental group could be compared to a group who engage in an exercise programme prescribed using 'traditional' methods to empirically assess the impact of cognitive appraisal strategies and affect upon exercise adherence. Remaining within the context of hedonic theory, future research should also consider the reductions in affective valence that were observed at the end of exercise compared to the beginning of exercise in study three. The potential implications that this progressive decline could have upon future exercise behaviour according to Fredrickson's (2000) peak and end rule are considerable. In order to directly investigate this concept, researchers should endeavour to employ reductions in exercise intensity towards the end of exercise and test the impact that this experimental manipulation has upon both reflections on the adversity of the exercise bout and choices about future exercise behaviour.

Methodological considerations

"How we are expected to write affects what we write about"

Richardson (2000b, p. 5)

Studies two and three both utilised the circumplex model of affect (Russell, 1980) as the underpinning framework for assessing affect. This decision was made based upon the recent call to focus on basic affect in exercise studies (Ekkekakis & Petruzzello, 2000; 2002). Specifially, Ekkekakis and Petruzello (2002) recommended that "it would be reasonable for research to follow a systematic progression from the general to the specific and from the (relatively) simple to the complex" (p. 36). Therefore, given that basic affect has now been investigated under a number of conditions and within a variety of populations whilst taking into account the methodological limitations of past research (e.g., Hall et al., 2002; Parfitt et al., 2006; Ekkekakis et al., 2007), a step towards investigation of the "complex" was deemed timely and necessary for the advancement of theoretical understanding. Therefore, study four sought to explore the complex nature of the relationship between perceptual, cognitive and affective dimensions by using an inductive, qualitative approach to investigation. Employment of this methodology enabled detailed exploration of individual differences, identification of specific affective states, sources of self-efficacy, and other cognitive variables that may have influenced affective variance. Although conclusions can not be made based upon the limited number of participants in this study, the approach enabled a detailed depiction of the individuality of the affective exercise experience. Importantly, the narratives also provided suggestions for a number of avenues for future experimental research into the relationship between cognitions and affect during exercise, thereby taking a step towards fulfilling Ekkekakis and Petruzzello's (2002) recommendation to follow a systematic progression towards the specific.

Richardson (2000a) identified that many recent authors have made reference to the fact that living and working in a post-modern climate, as we do today, has enabled researchers to explore methods of enquiry that go beyond traditional scientific methods. Richardson asserts that this approach to knowledge development embraces the *doubt* that any method or theory, discourse or genre, tradition or novelty has a universal claim as the 'right' or privileged form of authoritative knowledge. It was the adoption of this perspective that enabled a detailed exploration of the interindividuality and variability of low-active females' affective exercise experiences through the use of both quantitative and qualitative methods in study four.

Dale (1996) suggested that qualitative methods have gained more credibility as valid forms of enquiry in sport and exercise psychology, and that researchers have been encouraged to consider viewing the subjective experience of the athlete [or exerciser] as a viable source of information. This argument is upheld by the present research findings, as the value of using narrative profiles to represent interview material became apparent when the detail, variety and richness of the acute exercise experience were captured in study four. It is therefore recommended that future research into the exercise experience employ a mixed-methods approach to scientific enquiry by employing a combination of quantitative and qualitative research methods. This approach will help to identify components of the next level of the affect hierarchy (i.e., specific affective states) within exercise, cognitive antecedents to these states, and whether any differences between individuals with varying activity habits can be identified.

Conclusions

Overall, the results presented in this thesis indicate that even though low-active women feel better after exercise, affective valence during exercise can decline, and a substantial amount of interindividual variance at 'moderate' intensity can be explained by cognitive appraisal factors, particularly self-efficacy perceptions during exercise. The widespread range in the affective experience of exercise was also demonstrated by the use of narrative profiles, and the individualistic nature of the complex relationship between perceptual, cognitive and affective response factors during exercise was documented. Clearly, appraisal of the task and oneself is a continual process during exercise at ~VT, and directly influences the overall affective exercise experience for habitually low-active women. This has important implications for both theory and exercise interventions. Strategies that positively influence low-active individual's perceptions of self-efficacy during exercise are likely to have a positive impact upon affect during exercise. Future research should strive to identify whether, in line with hedonic theory (Kahneman, 1999), there is a causal relationship between during-exercise affect and chronic exercise behaviour.

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Appendices

1. Medical and physical activity questionnaire
2. Participant information and informed consent form
3. Borg's (1998) Rating of Perceived Exertion Scale
4. Feeling Scale (Hardy & Rejeski, 1989)
5. Felt Arousal Scale (Svebak & Murgatroyd, 1985)
6. Attentional Focus Scale (adapted from Baden et al., 2004)
7. Pre-Exercise Self-Efficacy Scale
8. During-Exercise Self-Efficacy Scale

Appendix 1 - Medical and physical activity questionnaire

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MEDICAL QUESTIONNAIRE

If you feel unwell on the day of a proposed test, or have been feeling poorly within the last two weeks, you are excluded from taking part in an exercise test. The considerations that follow apply to people who have been feeling well for the preceding two weeks.

NAME: ....

AGE: .... (yr) HEIGHT: .... (m) WEIGHT: .... (kg)

Details of last medical examination (where appropriate):

Date: .... *(day/mo/yr)* Location: ....

Exercise lifestyle:

(a) If you exercise regularly, what kind(s) of exercise do you do (for 20 minutes or more per session), and how often? (*Please circle the number of times per average week*):

Walking	1	2+
Running	1	2+
Cycling	1	2+
Swimming	1	2+
Skiing	1	2+
Rowing	1	2+
Gymnastics	1	2+
Martial Arts	1	2+
Aerobics	1	2+
Tune Up	1	2+
Popmobility	1	2+
Sweat Session	1	2+
Weight Training	1	2+
Field Athletics	1	2+
Racket Sports	1	2+
Rugby/soccer/hockey	1	2+
Others*	1	2+

*(*Please specify*) ....

- How long (on average) do you exercise per session? ....minutes.
- How long have you maintained this behaviour for? .... years .... months.

(b) Please summarise your past involvement in physical activity below:

....

....

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
…………………………………………………

Smoking: (*Please tick one*)

Never smoked	………	Not for > 6 months	………
Smoke < 10 per day	………	Smoke > 10 per day	………

Illnesses: Have you ever had any of the following? (*Please circle NO or YES*)

Anaemia	NO/YES	Asthma	NO/YES
Diabetes	NO/YES	Epilepsy	NO/YES
Heart Disease	NO/YES	High Blood Pressure	NO/YES
Other	NO/YES		

If you answered 'yes' to any of these, please provide details below.
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
……

Symptoms:
Have you ever had any of the following symptoms to a significant degree at rest or during exercise? That is, have you had to consult a physician relating to any of the following?

	Rest	*Exercise*
Breathlessness	NO/YES	NO/YES
Chest Pain	NO/YES	NO/YES
Dizzy Fits/Fainting	NO/YES	NO/YES
Heart Murmurs	NO/YES	NO/YES
Palpitations	NO/YES	NO/YES
Tightness in chest, jaw or arm	NO/YES	NO/YES
Other	NO/YES	

If you answered 'yes' to any of these, please provide details below.
………………………………………………………………………………………………
………………………………………………………………………………………………
……

Muscle or joint injury:
Do you have/or have had any muscle or joint injury which could affect your safety in performing exercise (*e.g.* cycling or running)? NO/YES*

*(*Please specify*) ………………………………………………………………………

Pregnancy:
Are you, or is there a strong possibility that you could be, pregnant. NO/YES

Medication:

Are you currently taking any medication? NO/YES*

*(*Please specify*) ....

Family History of Sudden Death:

Is there a history of sudden death in people under 40 years in your family? NO/YES*

*(*Please specify*) ....

The following exclusion and inclusion criteria will apply to this study:

Exclusion criteria: If you have any of the following, it is likely that you will be excluded from the study:

(a) Asthma, diabetes, epilepsy, heart disease, a family history of sudden death at a young age, fainting bouts, high blood pressure, anaemia, and muscle or joint injury.
(b) A recent illness or viral infection (including an upper respiratory tract infection) within two weeks of the experiment.
(c) Pregnancy.
(d) A history of smoking tobacco regularly for the last 6 months.
(e) Taking any medication that may adversely affect health or exercise performance.
(f) Taking recreational or performance-enhancing drugs.
(g) Ingestion of alcoholic drinks in the previous 48 hours.
(h) Regular participation in two or more recreational aerobic-exercise sessions (≥ 20 mins duration) per week, for at least the last 12 months.

Inclusion criteria:

(a) Female, aged at least 18 years and no more than 35 years.
(b) In good health at the time of testing.

If you are involved in more than one visit to the laboratory, you will be asked to complete the medical and physical activity questionnaire on each subsequent visit, to establish whether or not your health status has changed. If the investigator has any concern in this regard (see Exclusion criteria above), you will be excluded.

Signature .... Date ....

Appendix 2 – Participant Information and Informed Consent Form

UNIVERSITY OF LEEDS
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INFORMATION SHEET

TITLE OF INVESTIGATION: Exploration of Individual Experiences of Exercise

You have been invited to take part in a research study looking at the feelings people experience when they exercise. In order to help you to understand what the investigation is about, please read the following information carefully. If there are any points that need further explanation, please ask a member of the research team. It is important that you understand what you are volunteering to do and are completely happy with all the information before you sign this form.

Why have I been chosen? You have been selected as a possible participant in this investigation because you are not currently exercising regularly, but have expressed an interest in learning more about starting an exercise programme. Before you become a participant, you will complete a medical questionnaire. People who have asthma, heart-related and/or circulatory problems, hypertension or any other potentially problematic condition will not be allowed to take part in the study.

Do I have to take part? It is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and will be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part? You will be asked to visit the laboratory on 5 separate days, within a two-month period. Each visit will last no more than 1 - 2 hours.

On your first visit you will be introduced to the laboratory staff and shown all the equipment that will be used in the study. You will be asked to complete a confidential questionnaire that will allow us to obtain information related to your general health, and will allow us to quantify your past exercise/activity involvement. You will have an ECG (tracing of your heart activity) to check for some rare conditions that can be dangerous during severe exercise. If anything unusual is found, you will be referred to your GP to check that it is a false alarm: you will not be able to continue with the study until this has been done. You will then be asked to perform exercise of varying intensities on an exercise bike so that you can get used to the environment you will be exercising in and the equipment that will be used. It will also give you the chance to ask any questions about the study before your subsequent visits to the laboratory.

On a second visit, you will be asked to complete some more short questionnaires and perform what is called a "progressive exercise test" on an exercise bike. In this test, we will ask you to breathe through a "snorkel" type mouthpiece with a nose clip in place. This is so we can monitor the air you breathe in and out. During this test, the work-load will start very low and increase gradually every minute. The idea is that you keep going until you can do no more. The test will be stopped when you decide you can go no longer. The results of this test will allow us to select the work-loads for the subsequent tests.

On your subsequent visits (i.e. three), the testing set-up will remain the same, but the exercise protocol will change. Instead of the work-load gradually rising throughout the test, the work-load will remain at a constant moderate level throughout the test. The duration of the exercise bout may vary from one visit to the next, and you may not always be informed of the duration of the test, though it will never exceed 1 hour. You will also be asked to complete some simple questionnaires before you exercise, and to respond to some questions about how you feel throughout and after each exercise test. You may also be asked to participate in two short interviews (one will take place during your second session and one will take place during your last session. These interviews will last approximately 20 minutes and will include questions about your physical activity history and about your feelings and thoughts during the exercise bouts.

Finally, you will not be able to consume any alcohol 48 hours prior to each lab visit. You will be excluded from participating in this study if you take drugs (prescribed, non-prescribed, recreational and/or performance enhancing drugs), if you smoke, have asthma, or if you are pregnant.

What are the side effects of taking part? The exercise tests may leave you feeling tired and perhaps 'stiff', but there should be no long-term discomfort.

What are the possible disadvantages and risks of taking part? Exercise has a negligible risk in healthy adults, however maximal exercise does carry a small risk of inducing myocardial ischaemia ("heart attack"). The primary symptom of myocardial ischaemia is chest pain on exertion. If you experience any unusual sensations in your chest during the experiment, you should cease exercising immediately. Your heart rate will be monitored via adhesive electrodes placed at points on the chest (an "electrocardiogram" or ECG). In the unlikely event you experience serious problems during the exercise, personnel with life-support training are in the laboratory at all times during the test and approved emergency procedures are in place.

At the end of the 'progressive exercise test' you will be very tired (exhausted), your legs will be very heavy and you will be out of breath. It is also not uncommon to feel a little light-headed and sometimes nauseous. You may experience difficulty swallowing while breathing through a mouthpiece and wearing a noseclip; this is due to a slight but transient pressure build up in your ears. Also, some participants' experience increased salivation while breathing through a mouthpiece. The subsequent tests will be at a lower intensity, so you are unlikely to feel so tired.

What are the possible benefits of taking part? The results from the exercise tests will give you a good idea of how fit you are. At the end of the study, the researcher will take the time to explain the results to you from an exercise psychology perspective. That is, how *you* can use the results from the exercise tests and the questionnaires you complete about yourself to learn more about your *personal exercise psychology*, and how to prescribe exercise for yourself in the future that you are more likely to stick to and enjoy.

What if something goes wrong? There will always be a trained first-aider at hand, and throughout the progressive exercise test a technician, fully trained in Intermediate Life Support, will be present. In the event of an untoward incident, the technician will provide intermediate life support including chest compressions and ventilation, and will apply an automatic defibrillator (if necessary) until emergency medical staff are on hand. If you are harmed by taking part in this research project, there are no compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it.

Will my taking part in this study be kept confidential? All information which is collected about you during the course of the research will be kept strictly confidential.

What will happen to the results of the research study?
This research is being conducted as part of a doctoral dissertation, and it is likely that the results will be published in a peer-reviewed scientific journal once the study is completed. You will not be identified in any publication. If you would like a copy of the full publication, please contact the primary researcher (Amy Welch - see contact details below). If you are worried about any unwanted side effects from any of the above procedures, or want to know more about the study you should contact one of the researchers named below:

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Project Title: Exploration of Individual Experiences of Exercise

Consent Form

I .... (Print name)

give my consent to the research procedures which are outlined above, the aim, procedures and possible consequences of which have been outlined to me.

Signature ....

Date ....

Appendix 3 – Borg's (1998) Rating of Perceived Exertion Scale

Borg's Scale of Perceived Exertion

Instructions

During your exercise session we want you to listen to your body and pay close attention to how hard you feel the work is. The feelings you report should be your total amount of exertion and fatigue, combining all feelings of physical stress, effort and fatigue. Do not concern yourself with any one factor, e.g. leg pain, or shortness of breath, but try and concentrate on your inner feeling or effort. Try not to under or over estimate, be as accurate as you can (Borg, 1998).

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**
20	

Appendix 4 – Feeling Scale (Hardy & Rejeski, 1989)

Feeling Scale

Please select a number that represents your true feeling at this point in time using the feeling scale below (Hardy and Rejeski, 1989).

+5 very good

+4

+3 good

+2

+1 fairly good

0 neutral

-1 fairly bad

-2

-3 bad

-4

-5 very bad

Appendix 5 – Felt Arousal Scale (Svebak & Murgatroyd, 1985)

Felt Arousal Scale

Estimate here how aroused you actually feel. Do this by circling the appropriate number. By 'arousal' here is meant how 'worked up' you feel. You might experience high arousal in one of a variety of ways, for example as excitement or anxiety or anger. Low arousal might also be experienced by you in one of a number of different ways, for example as relaxation or boredom or calmness (Svebak and Murgatroyd, 1985).

1 Low Arousal

2

3

4

5

6 High Arousal

Appendix 6 – Attentional Focus Scale (adapted from Baden et al., 2004)

Name................................

Associative and Dissociative Thoughts

This experiment will monitor the types of thoughts you have while cycling. I will not want to know details of what you are thinking, only whether your thoughts are broadly associative or dissociative.

Associative Thoughts: Thoughts about your body and how it is reacting to the exercise, for example where your attention is focused on the body and your thoughts are about physical sensations such as heart pounding, sweatiness, heavy breathing, sore muscles, pain, etc.

Dissociative Thoughts: These are all thoughts that are not about physical sensations or the exercise. External thoughts are like daydreams and may distract you from the bodily signals arising from the exercise.

Classify the following thoughts as associative or dissociative and then check at the bottom of the page to see if you got them correct.

1. "I'm feeling tired."
2. "I wonder how my friend is getting on in her new home."
3. "Breathe deeply, relax shoulders..."
4. "Just a couple more minutes to go and I can rest."
5. "Oh dear, I forgot to get some bread."
6. "Keep going, you can do it."
7. "That new sitcom is very funny."
8. "My feet are beginning to hurt."

During exercise:

At regular intervals I will ask you to point to a segment on the line below that represents the approximate ratio of associative thoughts to dissociative thoughts over the last segment of the exercise. But please don't think that you have to be aware of exactly what you are thinking all the time, an approximate proportion is fine. Also, quite often dissociative-type thoughts are like daydreams and quickly forgotten. So, although you may start off by thinking that your feet hurt, you may then go on to speculate whether to get new trainers and then may find you are in a daydream you may not remember. In this case, just the original thought counts as an associative thought and the rest is dissociative.

Associative ■ ■ ■ ■ □ □ □ □ □ □ Dissociative

Answers: Associative thoughts = 1, 3, 4, 6, 8; Dissociative thoughts = 2, 5, 7.

Appendix 7 – Pre-Exercise Self-Efficacy Scale

PRE-EXERCISE QUESTIONNAIRE

Please state how **confident** you are that you can carry out each of the activities listed below. Rate your degree of confidence by recording a number from 0 to 100 using the scale given below.

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Cannot do at all					Moderately certain can do					Certain can do

CONFIDENCE (0 – 100%)

I am **CONFIDENT** that I can:

1. Cycle for 10 minutes at a moderate pace without stopping. _____%
2. Cycle for 20 minutes at a moderate pace without stopping. _____%
3. Cycle for 30 minutes at a moderate pace without stopping. _____%
4. Cycle for 45 minutes at a moderate pace without stopping. _____%
5. Cycle for 60 minutes at a moderate pace without stopping. _____%

MEAN.._____%

Appendix 8 – During-Exercise Self-Efficacy Scale

DURING-EXERCISE QUESTIONNAIRE

Please state how **confident** you are that you can carry out each of the activities listed below. Rate your degree of confidence by recording a number from 0 to 100 using the scale given below.

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Cannot do at all					Moderately certain can do					Certain can do

CONFIDENCE (0 – 100%)

I am **CONFIDENT** that I can:

1. Cycle for another **10** minutes at the current pace without stopping. _____%
2. Cycle for another **30** minutes at the current pace without stopping. _____%
3. Cycle for another **60** minutes at the current pace without stopping. _____%

MEAN.. _____%

Appendix 9 – Interview Guide

Introduction: "I am going to ask you a series of questions in order to gain a deeper understanding of your experience of the exercise bout you just completed and of your past physical activity experience. There is no right or wrong answer to any of the following questions and you are in no way being judged based upon the answers you give. You're encouraged to give detailed answers and to expand upon any thoughts, feelings and opinions you have about each topic we cover.".

Interview 1 – immediately after incremental exercise test (session 2, during recovery time).

Questions:

1. How would you describe the overall exercise experience?

2. Can you please describe your feelings throughout the exercise bout?

    - Probe to expand on thoughts (pos/neg), feelings, confidence, anxiety, pleasure/displeasure, pain, specific emotions.

    - Probe to gather information about the beginning, middle, and end of the exercise test.

3. (Show them their 'circumplex affective profile' and explain). To what extent does this graph represent your feelings throughout the exercise?

    - Ask them to expand on how they felt at specific points if they do not volunteer the information.

Interview 2 — immediately after last exercise test (session 4, during recovery time)

Introduction: Can I ask you to think about the two 30 minute exercise sessions? In one you were aware of the time and in the other you were not.

1. Did your experience of these two exercise bouts differ in any way?
    - Can you describe the differences? What about towards the end of the exercise bout?
    - Why do you think there was/wasn't a difference in your experience?
    - Probe about thought patterns – +ve/-ve?
    - Probe about confidence changes.
2. (If do not get enough info from question) Can you tell me about any changes in your confidence in your ability to complete the task in the different exercise sessions.
    - If so, why do you think this happened?
3. To what extent did your feelings during the first moderate intensity exercise bout you completed differ from the second and third sessions?
4. To what extent did you participate in physical activity when you were younger?
    - Can you tell me a bit about that?
    - Probe to discuss childhood participation, parents attitudes towards sport/physical activity, own attitudes, any change into adulthood?
5. (Depending on last answer) Can you tell me a bit more about your physical activity involvement and experience in recent years?
    - Probe to find out: a) how long is it since they last exercised regularly/if they ever have; b) why they exercised regularly; c) when and why this behaviour stopped.
6. Some people say they enjoy exercise, some people say they dislike it. How would you describe your general experience of exercise?
    - Why do you think that is?
    - Probe participant to give their opinions: find out whether they think it is something innate or whether they think their development influenced their enjoyment of physical activity.