Affective Responses to Exercise: Understanding Changes in Perceptual and Cognitive Processes

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Affective Responses to Exercise: Understanding Changes in Perceptual and Cognitive Processes

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Abstract

The severe health implications associated with physical inactivity highlight the need for research aiming to elucidate mechanisms underlying individuals' experience of exercise. Affective responses to exercise have been identified as a central factor shaping exercise behaviour (Ekkekakis, 2003; Kwan & Bryan, 2010; Williams, et al., 2008). Research identifies that external and internal factors influence affective evaluations of exercise. One external factor influencing the evaluation of affective responses is the environmental stimuli comprising the exercise setting (Antoniewicz & Brand, 2014; DaSilva, et al., 2011). Therefore, study one examined the influence of environmental cues on affective and cognitive responses to exercise in an ecologically valid setting. Results revealed significant interactions between environmental cues and affect, and motivation; this suggests that intra-individual processes may influence exercise behaviour. The thesis subsequently investigated internal processes that influence affective evaluations of exercise; in particular, processes underlying the recall of affective experience (Kahneman, et al., 1993). Study two examined individuals' recall of exercise related affect over a period of two weeks using a randomised control crossover design. Results indicated that exercise related affect fluctuated over the two-week period with a significant drop at 24 hours post low-to-moderate and high intensity exercise trials. Additionally, recalled affect better predicted anticipatory feelings than affect recorded during exercise. The study also found partial support for the peak and end rule particularly for the high intensity exercise. Extending study two's findings, study three explored the recall of exercise related affect and anticipatory feelings using an experimental design with a self-paced exercise protocol. The study revealed significant changes across post-exercise recall with follow-up measures at 8 and 24 hours indicating a substantial decline in affect. Overall findings revealed that contextual factors promote positive affect when aligned with one's goals; however discordant contextual cues and goals can thwart positive affective responses. Further, recall of affective experiences of exercise dynamically change over time and recalled affect can predict anticipatory feelings of exercise. Lastly, all studies' findings emphasise on the imperative role of idiographic analysis in research on affective responses to exercise.

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Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the University Ethics Committee on 10.06.2013 for study 1 (RE-HLS-HLS-12-160413); 25.02.2014 for study 2 (RE-HLS-13-140210-52f93bb32db5e); and on 17.12.2014 for study 3 (HLSMS271114).

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1. Introduction

1.1 Introduction

Physical activity and a healthy diet have been acknowledged as being central factors for the maintenance of a healthy lifestyle (Buckworth, Dishman, O'Connor, & Tomporowski, 2013; World Health Organization, 2013). Thereupon researchers in exercise psychology have directed their focus on developing knowledge on how to improve physical activity levels in populations.

Until recently much research attention has been directed towards understanding cognitive, social, and environmental influences on inactive behavior (Bauman, et al., 2012). However, the predominant variables measured across studies (e.g., attitudes, intentions, outcome expectancies, social support) explain only a modest amount of behaviour; indicating a weak association between key constructs (Hagger & Chatzisarantis, 2014; Trost, Owen, Bauman, Sallis, & Brown, 2002). Recently, one important factor that has been highlighted as meaningfully impacting upon whether and how individuals engage in physical activity is the affect experienced during a bout of exercise (Ekkekakis & Petruzzello 2000). The endorsement is grounded in the acknowledgment of the motivational properties of affect experienced in exercise and have been found to augment positive and negative affect as well as behaviours that generate desirable affective states (i.e., high positive affect and low negative affect) and promote the likelihood of being performed in the next future (Higgins, 2006; Loewenstein, 2000). An increasing number of research studies have supported these prepositions, suggesting that experiencing elevated positive affect and lower negative affect during bouts of exercise are associated with greater current and future physical activity (Kwan & Bryan, 2010; Schwerdtfeger, Eberhardt, Chmitorz, & Schaller, 2010; Williams et al., 2009). Considering the growing volume of research on affective responses, one area that has

been neglected relates to the contextual factors that have high ecological validity and can potentially influence exercise related affect. This line of enquiry will be the focus of the first study within the thesis. Furthermore, research has shown that the decision to become and remain physically active is prominently reliant on the memory of affective experiences arising from exercise (Miron-Shatz, Stone, & Kahneman, 2009). In particular, the retrospective global evaluation of the pleasure or displeasure associated with a past exercise experience is prone to guide subsequent activity. The following studies included in this thesis (i.e., Study 2 and Study 3) will further explore this phenomenon in order to better understand how individuals generate the recalled affective experiences of exercise and how does it change over time.

Importantly, while the evidence supporting the psychological beneficence of acute exercise has proliferated in recent years, the development of knowledge has been partially inhibited by inconsistent and often ambiguous terminology across physical activity and exercise research, which is in particular problematic when attempting to synthesise literature and further examine the constructs. Therefore, the initial objective of this thesis is to determine the terminology followed by the current guidelines for physical activity among adults and children.

1.2 Terminology

Physical activity is defined as any skeletal muscle activation in energy expenditure beyond that of a resting level (Caspersen, Powell, & Christenson, 1985). *Exercise* is a subcategory of physical activity as it engages bodily movement produced by skeletal muscles which expend energy. Exercise is a type of physical activity that is planned, structured, repetitive and purpose i.e., to improve or maintain one or more components of

physical fitness as an objective (Caspersen et al., 1985). Physical fitness is a set of attributes that people have or people achieve; being physically fit is defined as having the ability to carry out daily tasks with vigor and alertness, without excessive fatigue and with sufficient energy to enjoy leisure-time pursuits (Caspersen et al., 1985). Components of physical fitness include health and skills/athletic ability.

As previous research (e.g., Haskell et al., 2007; Lee, Shiroma, Lobelo, Puska, Blair, & Katzmarzyk, 2012) asserts, insufficient participation in physical activity is associated with lower risk of several chronic diseases such as coronary heart disease, high blood pressure, stroke, falling, metabolic syndrome, type 2 diabetes, breast cancer, colon cancer and depression. Participating in regular exercise on the other hand has been shown to enhance health with increased cardiorespiratory and muscular fitness, healthier body mass and composition, improved bone health, increased functional health and improved cognitive function (ACMS, 2014; Buckworth, Dishman, O'Connor, & Tomporowski, 2013; Lee, et al., 2012). The importance of targeting worldwide inactivity has been enforced by recently published data that highlight continuously rising numbers of children and adults overweight and obesity levels (ACMS, 2014; Butcher, Sallis, Mayer, & Woodruff, 2008; WHO, 2013). Thus, encouraging greater participation in physical activity among sedentary individuals offers a promising path toward improving their health status.

In order to maintain healthy living it has been recommended that adults should exercise for at least 150 min in a week at a moderate intensity, or 75 min a week at a vigorous intensity (Haskell et al., 2007; USDHHS, 2000). It has been recommended that a mixture of moderate and vigorous is also beneficial for health (ACMS, 2014). Children and young people are recommended to exercise for at least 60 min daily with a moderate to vigorous physical intensity (MVPA; ACMS 2014; www.gov.uk, 2010). Recently, it

has been recommended (ACMS, 2014; Ekkekakis, 2013) that exercise participation, and in particular exercise intensity, should be quantified by using metabolic equivalent (MET) units which describe the energy expenditure of a specific activity. A MET is a ratio of the rate of energy expended during an activity to the rate of energy expended at rest (ACMS, 2014). Health benefits of physical activity depend mainly on total weekly energy expenditure due to physical activity, within range of 500 to 1000 MET min per week. It has been advocated that 500 MET minutes a week results in a substantial reduction in the risk of premature death, but activity of more than 500 MET minutes a week is necessary to achieve a substantial reduction in the risk of breast cancer (ACMS, 2014; Nelson et al., 2007). According to the guidelines by ACMS (2014) light-intensity exercise activities are defined as 1.1 MET to 2.9 METs, moderate intensity activities are defined as 3.0 to 5.9 METs; for example, walking at 3.0 miles per hour requires 3.3 METs of energy expenditure and is considered a moderate intensity activity. Vigorous intensity is defined as 6.0 METs or more; for example running at 6 miles per hour for 10 minutes results in 10 METs and is classified as vigorous activity.

The remainder of this thesis is organised as follows; first the review of literature is presented, followed by three empirical studies, general discussion alongside limitations and future research directions, and the conclusion. Whilst the literature review that precedes the reported studies is comprehensive, it is also complementary to the reviews offered in the subsequent chapters regarding the studies comprising the program of research. The proposed organisation of the thesis aims to provide a focused analysis of the distinct aspects of the program of research and the studies presented within.

2. Review of literature

2.1 Correlates of physical activity

Despite the many health benefits having been identified as being derived from physical activity, individuals often fail to achieve recommended levels of physical activity (Buckworth, Dishman, O'Connor, & Tomporowski, 2013; Lee et al., 2012). A number of studies have specified that within the first 6 months of the uptake of physical activity, more than 50% of those who begin to exercise subsequently terminate their participation (Butcher, Sallis, Mayer & Woodruff, 2008; Dishman, 2001; Wilson & Brookfield, 2009). To address the problem of the high frequency of dropouts, and further understand why people do not adhere to exercise, research has examined a number of correlates and barriers to physically active lifestyle. Correlates, as defined by Buckworth and Dishman (2002) are reproducible associations that are potentially instrumental; however it is important to note that data from correlational studies only highlight associations and not causality. In the field of exercise, extensive research (e.g., Buckworth, Dishman, O'Connor, & Tomporowski, 2013; Lewis, Williams, Martinson, Dunsiger, & Marcus, 2013; Netz, Zeev, Arnon, & Tenenbaum, 2008) has been carried out to identify the factors that increase or decrease the likelihood that individuals will adopt and maintain an active lifestyle; the majority of research has relied upon cross-sectional or prospective designs.

Buckworth, Dishman, O'Connor, and Tomporowski (2013) reviewed the extant literature and synthesised a number of demographic and biological, psychological, behavioural, social and cultural, and environmental correlates of physical activity that have been identified in exercise research. Demographic and biological factors that were positively correlated with physical activity included education, gender, genetic influence, and income, whereas negative correlates to physical activity included age, overweight/obesity, and ethnic background. Psychological factors that were associated

with higher levels of physical activity involved enjoyment of exercise, outcome expectancy values such anticipated from physical activity benefits, perceived health and fitness, intention to exercise, self-efficacy, self-motivation, self-schema and perceiving oneself as an exerciser. Psychological factors that correlated negatively with physical activity were perceived barriers to exercise, perceived lack of time, and mood disturbance. Behavioural, social and cultural factors which were positively associated with adopting an active lifestyle included dietary habits, past exercise programs, process of change, activity history during adulthood, physical influence, and social support. Behavioural factors that were negatively associated included smoking. Lastly, physical environment factors that were shown to be associated with higher physical activity included enjoyable scenery, access to facilities (both actual and perceived), satisfaction with facilities and dog ownership. Negatively associated environmental factors were climate and season. Regarding physical activity characteristics, the two factors that were repeatedly shown as negatively associated with physical activity were intensity and perceived exertion.

Further, studies have revealed that a lack of time and lack of enjoyment are among the most commonly reported barriers for engaging in exercise (Biddle, Mutrie, & Gorely, 2015). A study by Netz, Zeev, Arnon, and Tenenbaum, (2008) showed that among the reasons for avoiding exercise are environmental, personal and health related reasons. In particular the study by Netz and colleagues found that lack of clothes/equipment, the high price to use facilities, or lack of access to the facilities, are the most cited external reasons reported by individuals. Personal factors reported as reasons for omitting exercise, include a lack of enjoyment, and a self-perception of not being a "sporty" type. The study also found that a lack of time and motivation as well as low perceived ability and self-esteem to be factors associated with insufficient physical activity. A related study by Pridgeon and Grogan (2012) found upward social comparison, gym culture and habit

were interpreted and experienced differently by male and female gender groups and simultaneously contributed to both, adherence and non-adherence. Additional research has highlighted that insufficiently active individuals tend to report more reasons for omitting exercise than those who are more active (Salmon et al., 2003).

Increasing knowledge of the characteristics that are associated with physical activity in specific populations has promoted the conception of personalised interventions that are more likely to meet the needs of the target group and as a consequence boost the probability of maintaining the behaviour change (Baranowski, Anderson, Carmack, 1998; van Sluijs, McMinn, & Griffin, 2008). Further, the awareness of diverse correlates of physical activity has also encouraged scholars to revise methodological approaches as well as to make improvements in theoretical models used in exercise research and interventions (Biddle, Hagger, Chatzisarantis, & Lippke, 2007; Lewis, Williams, Martinson, Dunsiger, & Marcus, 2013; Van Sluijs, McMinn, & Griffin, 2008).

Correlational studies have provided somewhat useful information for the design of interventions targeting low activity levels; however, the effect found in these studies has been rather modest with fewer than half having a substantial impact on changing behaviour towards more active lifestyle by improving physical activity levels (Baranowski, Anderson, & Carmack, 1998; van Sluijs, McMinn, & Griffin, 2008). Further, a meta-analysis by Webb and Sheeran (2006) provided summary of the effectiveness of health behaviour interventions based on studies with experimentally manipulated intentions. Results highlighted that health behaviour interventions based on psychological models of behaviour change are often fairly good at changing intentions (d = 0.66, 95% CI = .51 to .82), however their impact on altering behaviours is much worse (d = 0.36, 95% CI = .22 to .50). A meta-analysis by Hagger, Chatzisarantis, and Biddle (2002) which reviewed intervention studies that operated on the theory of planned

behaviour (TPB; Ajzen, 1991) showed that TPB intervention could explain 45% of variance in activity intentions although only 27% of the variance in activity behaviour. Results indicated that while TPB is feasible for explaining individuals' planning of physical activity, large portion of behavioural variance rest unexplained. To address this limitation, scholars have recently started to explore variables outside the traditional social-cognitive frameworks, including environmental (Gordon-Larsen, McMurray, & Popkin, 2000) and affective (Williams, 2008; Kiviniemi, Voss-Himke, & Seifert, 2007) factors.

2.2 Theoretical frameworks used to explain affective phenomena

Research has documented over the past four decades that emotional reactions are among the most prevailing experiences of everyday life (Baumeister, Vohs, DeWall, & Zhang, 2007; Gollwitzer, 1999; Weiner, 1985; Schwarz, 2012; Winkielman, et al., 2007). Studies exploring this proposition have shown that the experience of affective states profoundly influence cognitive processing and are an important source of information used when opting for subsequent behaviour (Baumeister, et al., 2007; Schwarz & Clore, 2007; Winkelman, et al., 2007).

In the literature, emotions are described as powerful precursors of behaviour from a motivational perspective (Baumeister, et al., 2007; Frijda, 1986; Williams, 2008) with certain elicited emotions acting alone as a function of the achievement outcome (i.e., general feelings like positive or negative) (Weiner, 1985). Further, research suggested that emotions serve both functions, to reorganise existing goals or intentions as well as to generate new goals (e.g., Frijda, 1986). Studies that explored the impact of emotions on generating new goals highlighted two underlying mechanisms i.e., emotions or their

anticipation generate hedonistic desires (e.g., Baumeister, Vohs, DeWall, & Zhang, 2007).

Moreover, Schwarz's (2012) "*feelings as information*" theory proposes that individuals attend to their feelings as a source of information with distinctive feelings providing specific types of insight. The information attended is likely to concern the results of unconscious appraisal processes, the occurrence of changes in the person's belief-desire system or information about the value of objects and events including actions and their consequences. As illustrated by Schwarz and Clore (2007) nervousness experienced when meeting a stranger or beginning a novel activity may function to inform the decision-making system about the subconscious appraisal of the encounter as threatening. Similarly, a pleasant feeling experienced when considering a possible course of action could serve to signal the subconscious approval of the action and mark it as a good one to choose (Schwarz & Clore, 2007).

Considering an evolutionary perspective, affective states (i.e., pleasant vs. unpleasant) provide critical evolutionary adaptive functions serving as feedback about the accuracy and effectiveness of our previous choices and behaviour (Baumeister, et al., 2001). Moreover, according to this view positive feelings are encoded as desirable, beneficial, and carry information about pleasant outcomes from our activity; whereas negative feelings are understood as undesirable, harmful, and are associated with a threat (Russell, 2003; Ekkekakis, 2003). Importantly, research literature highlights that negative feelings are more profound than positive as they attract stronger attention e.g., when making judgments; people consistently weigh the negative aspects of an event or stimulus more heavily than the positive ones (Kahneman & Tversky, 1984).

Further, Batson, Shaw and Oleson (1992) describe the function of affect as being an indicator of preference, which informs the organism experiencing it about those states

of affairs that it values more than others. Specifically, change from a less valued to a more valued state is accompanied by positive affect; change from a more valued to a less valued state is accompanied by negative affect with intensity of experienced affect revealing the magnitude of the valued preference. Given this function, affect seems crucial to the very existence of motivation. Further, it has been advocated that individuals' information processing is necessarily selective and that the seeking of pleasure and avoidance of displeasure are the most important principles on which this selectivity is based (Finucane, Alhakami, Slovic, & Johnson, 2000; Kihlstrom, Eich, Sandbrand, & Tobias, 2009). In consideration of Simon's (1983) concept of "bounded rationality", which underlies the presence of irrational behaviour in decision making, Kahneman (2003) proposed that humans are inclined to implement heuristics and biases that reduce the complexity of problems to more manageable levels when making decisions. One heuristic forwarded by Finucane and colleagues (2000) relates to affect and highlights that judgments and decisions are heavily impacted upon by affective responses.

One central theoretical framework that connects the aforementioned propositions is hedonic theory (Bentham, 1824/1987; Frederick & Loewenstein, 1999; Kahneman, 1999; Williams, 2008), which suggests that individuals are prone to engage in activities they consider to be pleasant and avoid those perceived as unpleasant. The preference is grounded in an individuals' perceived utility of a behaviour or an experience, which is defined by one's affective response to the behaviour, and determines whether the behaviour will be repeated. Hedonic theory has been shown to play a principal role in behavioural decision-making across many fields; social psychology (Baumeister, Vohns, DeWall, & Zhang, 2007; Emmons & Diener, 1986), behavioural economics (Kahneman, 1999), and neuroscience (Bechara, Damasio, & Damasio, 2000; Damasio, 1996). In exercise research, hedonic theory has been used to explain the affect-adherence

relationship (Ekekkakis, 2003; Williams, 2008); in line with the theory the affective response to physical activity has been posited as an important determinant of future physical activity (Rhodes & Kates, 2015; Williams, 2008). Despite the strong evidence supporting hedonic theory from diverse research fields, the theory has been used rather modestly in exercise research (Ekkekakis & Defermos, 2012; Williams, 2008).

Although research outlining how affect guides behaviour has grasped the attention of researchers across the globe, and as a consequence has generated substantial data (e.g., Baumeister, et al., 2007; Clore, 1994; Ekkekakis, 2003; Forgas, 1995; Winkielman, Knutson, Paulus, & Trujillo, 2007), frequently the researchers undertaking the studies have employed diverse conceptualisations or have not clearly specified the framework they used; therefore, it has been a challenge to draw consistent conclusions in review of the research.

A fundamental shortcoming in the extant research relates to the important distinctions between the constructs of affect, mood, and emotion which are typically ignored and the terms (i.e., affect, mood and emotions) are used interchangeably. One prevalent approach in exercise psychology research (e.g,. Ekkekakis, 2013) classifies affective phenomena into *core affect* which refers to the experiential quality of consciously felt emotion that comprise of valence (positive or negative) and its degree of arousal (low to high activation), also referred to as a Circumplex model (Ekkekakis & Petruzzello, 2002; Russell, 2003). The core affect by definition is a consciously experienced state; however, apart from the two dimensions of valence and arousal, does not differentiate between different emotions as it doesn't embrace appraisal.

Next, to core affect there are *blue-ribbon emotions*, which include consciously felt, fully developed feelings states that can be differentiated by discrete emotional states (Ekkakakis, 2013; Russell, 2003). Emotions are described as intense feeling states

(McDougall, 1908; Reisenzein & Doring, 2009; Russel, 1980; 2003) usually lasting only for seconds, not minutes, hours or days (Ekman, 1992). Most contemporary definitions suggest that emotion comprises multiple interconnected and coordinated components i.e., feeling, appraisal, physiology, expression, and action (Frijda & Scherer, 2009; Russell & Feldman Barrett, 2009). According to Scherer and colleagues (2005, 2009) emotion involves a coordinated response of the following five systems: i) the information-processing cognitive (appraisal) component; ii) the neurophysiological component (bodily changes); iii) the executive component, which prepares and directs responsive actions; iv) the expressive component, which communicates the emotion with the vocal and facial expressions; v) an experiential component, which monitors the internal state of the organism and its interaction with the environment and generates subjective feelings (i.e., "emotional experiences"). Scherer (2005) suggested that all subsystems underlying emotion components function independently much of the time and that the very nature of emotion as a hypothetical construct consists of the coordination and synchronisation of all of these systems during an emotion episode, driven by appraisal. Therefore, emotion is an episode of interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism. Frijda and Scherer (2009) claim that emotions are focused on specific events, involve a process of cognitive appraisal as a defining feature, influence most or all bodily subsystems which may become to some extent synchronized. Russell and Feldman Barrett (1999) outline that emotion can be defined as a complex set of interrelated sub events concerned with a specific object such as a person, an event, or a thing, past, present, or future, real or imagined. The co-occurring components that comprise a prototypical emotional episode include: core affect; overt behaviour congruent with the emotion (e.g., a smile or a facial expression of

fear); attention directed toward the eliciting stimulus; the experience of the particular emotion; and neural (peripheral and central) and endocrine changes consistent with the particular emotion.

Alternatively, there is *mood* which refers to a low-intensity, diffuse, and relatively long-lasting state that is primarily differentiated on valence (i.e., feeling bad or feeling good; Russell, 2003). According to Ekman (1992) mood is the longest affective experience lasting for hours or even days. Further, scholars suggested that mood is a product of appraisal with themes relating to anticipation whether one will have adequate resources to deal with challenges in the process of striving for one's goals (Morris, 1992) as well as linking moods to the expectation of future pleasure and pain (Batson, 1992).

Notably, the core affect as described by Russell (2003) and refined by Russell and Feldman Barrett (2009) is the most elementary affective state, which can be a component of emotion and mood however it can stand also by itself as a separate, consciously experienced construct. A compatible view that was built on this approach suggested Baumeister et al., (2007) suggesting that individuals have either automatic affective reactions such as likening or disliking something or they express their feelings by full-blown emotions which are more deliberate, fully conscious demanding attention and greater cognitive processing. Automatic affective reactions were described as occurring very quickly; simple states that tend to guide online behaviour and quick reactions. Notably, Baumeister and colleagues suggested that core affect termed by them as automatic affect involved a cognitive component beyond the valence. This cognitive component was described as involving sufficient information to alter subsequent cognitions and behaviour. The principal difference between the automatic affect and full-blown emotion was explained as 'time' in which the states appear, thus differentiating that when one is better suited, the particular state will guide behaviour. As a result

automatic affective responses, while not being blue ribbon fully conscious emotions, may contain information that is useful to alter subsequent cognitions and behaviour.

In consideration of research undertaken within the context of exercise, the predominant construct used to examine affective phenomena is core affect together with levels of arousal (Ekkekakis & Petruzzello 2000; 2002; Williams, 2008). One of the reasons for employing this construct rests in its diverse capacity to assess affective phenomena as it does not rely on a presence/ absence or magnitude of more distinct affective states (e.g., exhaustion, fatigue, invigoration); instead, capturing the full range of basic affective response to exercise. For example, there are individuals that do not perceive any changes in anxiety, tranquillity or activation; however, these individuals are likely to undergo some sort of change that may not align with the adjectives that are proposed to describe their experience. The use of core affect via basic dimension of valence (i.e., pleasant-unpleasant) permits a researcher to capture changes that occur in most participants. Secondly, the dimensional approach can involve the use of two single item scales; it has been recommended as being advantageous as it can be easily administered at multiple times, in particular during exercise when measurement has been identified as being of great importance when attempting to understand the affect-exercise relationship (Backhouse, et al. 2007).

1.4 Affect and exercise

Positive affect is a subjective mental state of energy and enthusiasm related to health and well-being (Ekkekakis, 2013) including longevity, immune function, and stress response (Sparrow, Vokonas, & Kawachi, 2001; Steptoe, Wardle, & Marmot, 2005). Affective responses to exercise are the subjective experience of positive and/or negative feelings in

response to acute exercise (Schneider & Kwan, 2013). Research indicates that one prominent feature impacting upon individuals' perceptions of exercise is the degree of pleasant and unpleasant feeling states that occur during and immediately after exercise (Ekkekakis & Petruzzello, 1999). A large number of studies have suggested that exercise makes people feel good (Allender, Cowburn, & Foster, 2006; Hyde, Conroy, Pincus, & Ram, 2011; Reed & Buck, 2009; Reed & Ones, 2006; Nasuti & Rhodes, 2013) by improving levels of self-reported positive affect (Arent, Landers, & Etnier, 2000). Further, studies show that exercise from 7 min (Reed & Ones, 2006) to 90 min (Backhouse et al., 2007) can significantly improve positive affect. It is important to note that some studies, although only a few, have reported negative psychological consequences after exercise trials; these include unpleasant affective states due to exercise of high intensity or long duration (e.g. Berger & Owen, 1988, 1992).

One theoretical framework proposed by Ekkekakis (2003, 2005), provides an in depth elaboration of the affect-exercise relationship. Specifically, the dual-mode model (DMM) suggests that affective responses to exercise are an expression of psychological mechanisms guiding the selection of adaptive doses of activity and preventing non-adaptive doses. The model predicts the occurrence of homogenous pleasure responses when the intensity allows for the maintenance of a physiologically steady state, permitting an individual to perform physical work without causing a significant perturbation of the homeostatic system. On the other hand, the model predicts homogenous displeasure when an activity's intensity exceeds a comfortable state for the body and the maintenance of a physiological steady state is threatening and leading to exhaustion. Moreover, the model suggests that at the point of transition from aerobic to anaerobic metabolism, affective responses will be diverse with some individuals reporting pleasure whereas others report displeasure. The variability in responses is grounded in an individual's aptitude in a

moment of potential trade-off; specifically weighing up benefits such as performing heavier work and gaining access to larger territories, with costs such as increased risk of injury, cardiovascular compilations, or immune suppression. Furthermore, the DMM predicts that cognitive factors (e.g., self-efficacy, social physique anxiety) will be primary determinants of affective responses at low intensities or intensities that are proximal to the aerobic-anaerobic transition. According to the model, at intensities exceeding the transition threshold affective responses will be determined by interoceptive cues such as respiratory or muscular cues. One popular index of an aerobic-anaerobic transition is ventilatory threshold (VT). Studies in various exercise settings offer support for the DMM (Ekkekakis & Dafermos, 2012; Ekkekakis, Lind, & Vazou, 2010; Ekkekakis, Parfitt & Petruzzello, 2011) and are explained in more detail in the following section of the thesis (p. 20).

Moreover, meta-analyses indicate that the affective judgment of exercise may be a stronger associate of physical activity than other correlates (e.g., self-efficacy) within adult (Rhodes, Fiala, & Conner 2009) and youth (Nasuti & Rhodes, 2013) populations. Further, positive affect experienced during exercise has been identified as an important predictor of future exercise behaviour (Annesi, 2005; Arent, Landers, & Etrier, 2000; Kwan & Bryan, 2010; Schneider, Dunn, & Cooper, 2009; Williams, et al., 2008). Studies with a prospective design have revealed that participants who responded to a physical task more positively (i.e., with a more pleasant evaluation), exhibited a stronger relationship between intentions and subsequent exercise behaviour (Kwan & Bryan, 2010) and were more likely to engage in exercise behaviour at 6 and 12 months in time (Williams, et al., 2008).

Further, there is growing evidence supporting the preposition that positive affect

can influence the initiation of participation in exercise through various factors such as the anticipation of feeling good and experiencing increased levels of energy (Kiviniemi, voss-Humke, & Seifert, 2007; Salovey & Birnhaum, 1989; Schwarz & Bohner, 1996). For example, in a study by Kiviniemi et al., participants with positive feelings towards exercise more often displayed willingness to engage in exercise than those whose beliefs about exercise were less positive or more negative.

Importantly, it has been highlighted that interpretation of physiological symptoms influence affective responses (Rose & Parfitt, 2010) and if individuals experience displeasure, a sense of exhaustion, pain or discomfort from their physical activity they are less likely to continue to exercise (Kelsey et al., 2006; Parfitt, Rose, & Burgess, 2006) as they may feel less confident in their ability to perform an action (i.e., lowered efficacy expectations; Salovey & Birhhaum, 1989), be less likely to engage in the action, and may find the outcome less attractive (Schwarz & Bohner, 1996). These findings are in line with the hedonic principle, which suggests that people choose to participate in behaviours that lead to positive affective responses and avoid those that are unpleasant (Higgins, 1997; Kahneman, 1999; Williams, 2008). Similarly, in line with hedonic theory it is suggested that exercise-related affective responses may influence adherence because many individuals report exercising for mood-related benefits (Thayer, Newman, & McClain, 1994).

Moreover, in line with theoretical advancements (Williams, 2008) regarding the impact of affective and environmental determinants of exercise, it has been suggested that the features of the exercise environment impact affective states by influencing self-perceptions and one's evaluation of exercise (Ginis, et al., 2003; Prichard & Tiggemann, 2010; Pridgeon & Grogan, 2012). Research which explored these prepositions found

differences in reported affective responses to exercise that was undertaken in laboratories vs. outdoor environments. In particular, it was demonstrated that there were systematic increases in affect when individuals exercised in natural outdoor settings with comparison to the laboratory settings (DaSilva, et al., 2011; Focht, 2009; LaCaille, et al., 2004).

Moreover, previous research demonstrates that the amount of pleasant and/or unpleasant affect from exercise greatly varies between individuals (Ekkekakis, Hall, & Petruzzello, 2005; Rose & Parfitt, 2010). Researchers have attempted to explain some of the variance between individuals' responses offering a number of factors that are likely to impact the affective responses, these were grouped by social-psychological factors such as personality characteristics, (i.e., extraversion; Rhodes & Smith, 2006), behavioural activation (Schneider & Graham, 2009), and characteristics of the exercise stimulus or situational factors such as intensity (Ekkekakis, Hall, & Petruzello, 2008), mode, and autonomy support (Rose & Parfitt, 2010). One prominent factor that influences the amount of pleasantness experienced from exercise, and which has gained the largest amount of support in the literature, is the intensity of exercise (e.g, Backhouse et al., 2007; Ekkekakis, Backhouse, Gray, & Lind, 2008; Ekkekakis, et al., 2004, 2005; Ekkekakis, Lind, & Joens-Matre, 2006; Williams, 2008).

2.4 Exercise intensity and affective responses

An underpinning factor that influences the amount of pleasantness experienced from exercise is the intensity by which it is undertaken (DMM; Ekkekakis, 2003; 2005; Ekkekakis, Hall, & Petruzzello, 2004). Until recently research suggested that affective responses to exercise are best explained by an inverted U model which claimed that only moderate exercise intensity is suitable for optimising affective responses to exercise as

neither low nor high intensities trigger desired changes in affective states (Ekkekakis, 2013).

Advancements in research have proposed that exercise intensity is connected with affective responses by a causal link that in result underwrites adherence (Ekkekakis et al., 2007; Ekkekakis & Lind, 2006). Research highlights that affective responses to exercise heavily depend on whether the intensity with which one exercises is either below, at, or above one's Ventilation threshold (VT); the point of VT is where a shift occurs from having a cognitive to interoceptive impact on psychophysiological state (Ekkekakis, 2003). Based on this categorisation, Ekkekakis and colleagues (Ekkakakis, 2003; Ekkekakis, Hall, & Petruzzello, 2000; 2002) proposed the dual-mode model (DMM) which outlines that inter and intra individual variability in affective responses is moderated by exercise intensity. Specifically, the model explains that at low and moderate exercise intensities (i.e., below and at the level of an individual's VT, where there is no threat to the homeostatic system), affective responses tend to be generated via cognitive appraisal which primarily include goals, perceived efficacy, social context and expectations (Rose & Parfitt, 2007; 2012; Welch, Hulley, Ferguson, & Beauchamp, 2007). Once exercise intensity increases beyond VT it becomes too demanding to maintain a physiological steady state and the associated cognitive appraisal becomes dominated by interoceptive cues that reduce pleasant affective responses and induce unpleasant affect (Ekkakakis, et al., 2005). Research has importantly noted that cognitive appraisal has the strongest influence on affective responses close to VT where interoceptive cues begin to arise with less of an impact at low intensities where there is also no influence of interocpetive cues on affective responses (Ekkekakis, 2003; Ekkekakis & Acevedo, 2006; Ekkekakis et al., 2005).

Further, Williams (2008) suggests that minimizing perceived exertion may be an

effective strategy to enhance adherence to physical activity programs. In line with this proposal, it is suggested that self-selected intensity protocols might address this objective as intensity that is self-selected is deciphered as more pleasant (Ekkekakis, et al., 2011; Parfitt & Hughes, 2009; Parfitt, Rose, & Burgess, 2006). This account is coherent with results from a study by Vazou-Ekkekakis and Ekkekkakis (2009) which concluded that a sense of autonomy associated with self-selected exercise intensity promotes improved feeling states and perceptual responses. Notably, previous research demonstrates that individuals, when asked to choose a preferred pace to exercise tend to select their exercise intensity around their VT level (Ekkekakis et al., 2005; Ekkekakis & Petruzzello, 2000; Parfitt, Rose, & Burgess, 2006). Moreover, studies that compare self-selected protocol and prescribed intensity reveal that individuals experience more positive affect from exercise when self-selecting intensity even when the intensity is higher in comparison with prescribed intensity exercise (Rose & Parfitt, 2007). These findings highlight the practicality and enhanced implications of self-selected intensity exercise for applied practices and in particular can be useful for exercise prescription.

2.5 Affective expectations

Expectation has been termed in the literature as anticipation of future consequences based on prior experience, current circumstances, or other sources of information (Tryon, 1994, p. 313). Anticipation of emotional outcomes is a prevailing aspect of the feedback theory proposed by Baumeister et al., (2007). According to this theory people learn to anticipate feedback they desire and as a result tend to alter their behavioural choices so that desirable feedback is realised. Research shows that a brief feeling of anticipation which provide initial information regarding what is about to

happen may be enough to steer a person away from doing something (Baumeister et al., 2001). Affective states, in particular are well suited for these processes because of their hedonic power which influence behavioural choices and can be swayed by the anticipation of feeling good or bad. Therefore, future behavioural choices may be influenced and consequently biased by anticipation of something positive and pleasant, or negative and unpleasant. Bandura (2001) has supported these findings suggesting that people are prone to anticipate the likely consequences of prospective actions, and select a course of action likely to produce desired outcomes and avoid detrimental ones.

Expectancies have also been shown to shape feelings and somatic sensations (Geers & Lassiter, 1999). It is proposed that emotions provide feedback about recent actions with positive emotions generally validating and supporting current behavioural choices and negative emotions indicating a threat or a failure. Further, if affective residue remains, the subsequent behaviour is likely to be affected by the remaining information during decision-making process because the automatic affective response will be released at the time of decision making implying avoidance in case of negative affective experience or approach in case of positive affective experience (Baumeister et al., 2001; 2007). Moreover, research highlights that individuals are motivated to avoid the experience of regret or disappointment and are most likely to make decisions and pick options that will minimise the likelihood of experiencing regret or disappointment (Schwarz, 2010). Additionally, it is proposed that unpleasant emotions involve more extensive processing of information in order to generate the evaluative ratings when compared to positive emotions (Affect Infusion Model, Forgas, 2005).

Affective feedback and interference processes have particular implications in exercise settings where individuals tend to primarily experience forms of displeasure,

physical exhaustion and even pain. Therefore, when an individual attempts to exercise following a previous experience of displeasure or pain, activated automatic affective responses may warn the individual not to repeat the behaviour (Baumeister, et al., 2007; Williams, 2008). Bagozzi, Baumgartner, and Pieters' (1998) study of dieting and exercise behaviour shows that anticipating emotional reactions to a goal is beneficial for achieving the goal by impacting upon motivation and subsequent behaviour.

A recent review by Dimmock et al., (2015) reveals that expectations of physical activity often drive subsequent evaluations. Additionally, the processes that underlie these expectations are influential in predicting salient outcomes such as interest and physical activity behaviour. Further, it was shown that when one is holding favourable expectations of upcoming exercise, the ratings were predictive of positive mood (O'Halloran, Murphy, & Webster, 2002) and motivation (Dimmock, Jackson, Podlog, & Magaraggia, 2013). It is important to note that whilst positive expectations were shown to predict positive feelings, a related line of research demonstrates that positive expectations about exercise can be inhibiting as they may predict disappointment and attrition (Desharnais, Bouillon, & Godin, 1986; Jones, Harris, Waller, & Coggins, 2005).

2.6 Affect and memory processes

According to Bower (1981), emotions can be viewed as memory units as they are linked to the memory system that facilitates access to mental representations associated with targets of judgment. Such associations, which are captured during prior experiences, are initiated in analogous situations by activating particular emotion nodes stored in memory (Bower, 1991; Forgas, 1991). The activation then spreads throughout neuronal circuits to mental representation of events associated with that emotion influencing further encoding and retrieval of events, objects and behaviours (Bower, 1981). Bower has also suggested

that the causes of the emotions are critical as people have a perceptual interpretive system that analyses and evaluates environmental stimuli for their emotional significance and it 'turns on' the appropriate emotion when the appropriate situation arises. In line with this proposal, work by Damasio (1994) proposes that emotional outcomes leave affective residues in the body, which he termed somatic markers. Specifically, Damasio proposed the Somatic Marker Hypothesis (SMH; 1993) which determined that emotional processes can guide or bias behaviuor, especially during judgment and decision-making. This argument has been supported by data showing that the cortical image of subjective feelings is built upon homeostatic (interoceptive) hierarchy hence viewing e.g., pain or muscle ache, as homeostatic emotions enables ready explanations of the interactions and emotional state. In practice it means that when individuals experience an emotional state through various physiological responses that occur in the body the information that is interpreted from these reactions is associated with the present situation.

Further, research by Kahneman, Wakker, and Sarin (1997) acknowledges the importance of affective experience in judgment and decision making, and proposes that not the entire affective experience is memorised. Instead, they suggest that people's retrospective, global evaluation of behaviours (the affective experience that they remember, in behavioural-economics terms as "remembered utility"), rely upon only salient moments of the experience and not aggregated and averaged entire affective experience. Fredrickson (2000) further suggests that the construction of a global evaluation involves both, memory (i.e., recalling our feelings) and judgment processes (i.e., the meaning attached to those feelings). The salient moments suggested as being particularly important were peaks (i.e., the moments were the intensity of affective experience was the highest) and the moment when the experience was terminated. The

studies that document these processes examine patients' memories from a painful operation (Fredrickson & Kahneman, 1993; Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993) and reveal that patients who opted for extending the operation with a brief milder finish remembered the procedure as being less unpleasant than those patients whose operation was terminated immediately after the procedure, finishing with a severe pain. In these studies, a duration neglect phenomenon was observed, this explains individuals' inability to accurately memorise the length of the completed affective experience (i.e., whether it was longer or shorter), having no effect on subsequent affective judgment (Fredrickson & Kahneman, 1993).

In the exercise setting, despite the growth of interest and call for studies examining the importance of post exercise affective states on exercise behaviour (e.g., Welch, Hulley, & Beauchamp, 2010) the research on affective memory from previous exercise is rather modest (Brewer, Manos, McDevitt, Corneluis, & Van Raalte, 2000; Hargreaves & Stych, 2012; Parfitt & Hughes, 2009; Zenko, Ekkekakis, & Ariely, 2016). For example, Brewer et al., examined whether reduced exertion for an additional duration at the end of an exercise session would result in exercise being perceived as less aversive despite the entire exercise session lasting longer. Results showed that averseness was in fact similar regardless of how the exercise finished, however the study found that 65% of the sample expressed a preference to repeat the longer exercise session. A study by Parfitt and Hughes investigated whether the extended period of milder exercise would change individuals' global evaluation reports. In particular, the study reported that inactive participants who exercised at an intensity 10% above VT for 15 min followed by 5 min at 20% below VT, ended their exercise session more pleasantly than those who exercised 10% above VT for 15 min. The proposed explanation of these results was that the average

global evaluation generated after the longer episode was more pleasant since the more positive end of exercise affected the memory of the whole experience (Schreiber & Kahneman, 2000). A study by Hargreaves and Stych (2012) in turn examined whether the peak and end rule contributes to global affective evaluation generated at 5, 15 min and 2 and 7 days post exercise. The study revealed that the amount of variance predicted by the peak and end rule decreased as more time has passed from the competed exercise which they remembered. Affective states at peaks and at the end of exercise explained 56% and 58% of the variance in global affective

evaluation at 5 min and 15 min post exercise, and 39% and 40% of the variance at 2 and 7 days post exercise. The results suggest that measures of affective states at peaks and at the end of the activity are better predictors of more immediate global affective evaluation than for global affective evaluation measured further in time because they explain more of the variance from individuals' responses.

Furthermore, research by Miron-Shatz, Stone, & Kahneman (2009) investigated retrospective evaluations of affective experiences showing that the memories from the experience and the recall of that experience can vary. The discrepancy between the reports of experience and the recall of that experience indicate an exaggeration of the recalled memory, in particular with regard to unpleasant emotions. Moreover, when unpleasant emotions intersect with pleasant emotions, negative affect is more likely to dominate the positive and result in an unfavourable evaluation of the entire experience. This line of research supports previous findings reported by Hunter, Philips, and Rachman (1979) in their examination of the accuracy of pain recall and whether such recall would decay over time. In this study, two groups of patients that underwent a neurosurgical examination were compared, one with a single recall at five days post-examination and the other group

with two recall points, one day after and again at five days post-neurosurgical examination. The results showed that patients who were asked to recall on two occasions, remembered the pain as having different and additional qualities (measured by selection of different words that described their pain), as well as being at a higher level of intensity. Interestingly, the group that recalled once at a 5 day post-baseline measurement reported a highly accurate recall of pain. These results suggest that at a time of approximately 24 hrs post-event, participants may experience some form of distortion in their recall evaluation of the experienced pain. Furthermore, within the study, an additional measure was taken that asked participants for some details of a person presented on the day of the initial examination. Interestingly, while 62.5% of patients were able to recall the person's profession after a 5 day interval, only 37.5% could recall this information after an interval of 1 day. Alas, there is no study in the exercise setting that has examined fluctuations in recall of affective experience and the global affective evaluation over time. Neither is there a study examining how recall differs after diverse exercise intensities where individuals may experience different levels of unpleasant feelings or pain.

In this thesis, a new perspective is offered in the evaluation of post exercise related affect. This approach integrates findings from exercise induced affect and memory literature to better understand information processing and judgments in exercise and human performance. This thesis focuses upon post exercise affect and the global affective evaluation rather than affect during exercise. Based on extant literature, it can be understood that the global affective evaluation that is generated after exercise changes over time (Hargreaves & Stych, 2012). It can also be implied that the global affective evaluation is a residue from previous exercise that directs future exercise behaviour. In the exercise setting there has been some evidence on memory gap and in particular the

Peak-end rule; however, no studies have examined how global affective evaluation changes over time. Moreover, no studies have examined the relationship between global affective evaluation and anticipation of subsequent exercise. This thesis aims to investigate these factors associated with the experience and recall of exercise related affect.

3. General methods

3.1 Introduction

This chapter depicts the theoretical frameworks used in the thesis and methodological procedures which are common to each study. Specific experimental procedures relating to each study will be detailed within the methods section associated with each study chapter.

3.1.1 Hedonic theory

Hedonic theory (Bentham, 1824/1987; Frederick & Loewenstein, 1999; Kahneman, 1999; Williams, 2008) was used as an underpinning framework for all the studies conducted in this thesis. Hedonic theory proposes that individuals are prone to engage in activities that consider as pleasant while avoiding those that are unpleasant. This preference is grounded in an individual's perceived utility of an experience, which is defined by one's affective response to that experience. In exercise research, hedonic theory has been used to explain the affect-adherence relationship (Ekekkakis, 2003; Williams, 2008), where pleasant experiences of exercise are associated with greater adherence (Rhodes & Kates, 2015; Williams, 2008).

3.1.2 Dual-mode model

Dual-mode model (DMM; Ekkekakis, 2003) proposes that affective responses to exercise are influenced by the continuous interplay between cognitive processes and interoceptive cues (e.g., ventilation, acidosis). The model suggests that the importance of the two factors shift as a function of exercise intensity, with cognitive factors being stronger determinants at intensities below and proximal to individuals' ventilatory threshold, and interoceptive factors gain dominance at intensities that disrupt the maintenance of a

physiological steady state (e.g., above individuals VT). Further, according to the DMM framework, individuals who exercise at low exercise intensities (e.g., below their ventilation threshold) are expected to show homogenous pleasant affective responses. When exercise intensity approaches the level of VT, there is an expectation of greater variability in affective responses that encompass reported pleasure and displeasure. At this intensity, there is strong influence of cognitive factors that underlie variability of the responses. In high intensity exercises (e.g., above VT), DDM predicts homogenous unpleasant responses with a strong influence of interoceptive factors. Further, previous research has revealed that when individuals are asked to choose a preferred pace for exercise they tend to select an intensity around their VT level (Ekkekakis et al., 2005; Ekkekakis & Petruzzello, 2000; Parfitt, Rose, & Burgess, 2006). In previous studies, the advantage of setting ones' own exercise pace was associated with elevated affect and linked to an enhanced sense of autonomy (Vazou-Ekkekakis, & Ekkekakis, 2009). Importantly, allowing individuals to set their own pace allows promotes greater ecological validity of studies. Grounded in the DMM, study one and three employed a self-selected intensity exercise protocol. Self-selected exercise intensity protocols were used in order to secure high validity of the studies. Study two utilised DMM in a cross-over study design, where all participating individuals were asked to perform a Vo2max test in order to establish their VT level. Next, in two study phases, participants performed exercise at below VT and above VT in a randomised order.

The procedures undertaken within the program of study gained ethical approval from the Northumbria University ethical advisory committee. All participants were informed of the nature, purpose, and possible risks of each experiment before providing written informed consent. In line with health and safety procedures used in the Department of

Sport, Exercise, and Rehabilitation labs, all participants were asked to complete a standardized medical history questionnaire prior to commencing the study. In the first study participants were unaware of the experimental manipulation of the testing environment due to the nature of the study being conducted. Immediately after the study took place they were fully debriefed and the study's manipulation was explained.

3.2 One-Item Measures

Although one-item scales are considered traditionally unreliable because their reliability cannot be estimated based on internal consistency (Vaughn, Lee, Kamata, 2012, p. 25), the brief and task-related questionnaires provide valuable and important information to athletes, exercisers, coaches, and scientists. Further, research shows that one-item measures can effectively indicate a person's state and account for more variance of behaviours than reliable long questionnaires that theoretically are linked to this behavior (Ekkekakis, 2012, p. 325). For example, a study by Tenenbaum et al. (2001) investigated the predictive power of motivational constructs on local muscular and running endurance using both well-established multi-item motivational constructs (e.g., goal orientation, self-efficacy, perceived physical ability and self-control) and task specific one-item questions measuring participants' commitment and readiness to sustain exertion and effort in the task. Results from the study indicated that the highest correlation ($r < .50$) was obtained between single item measures and physical effort tolerance demonstrating an advantage of using these scales over longer questionnaires. In conclusion, numerous authors have recommended that traditional reliability-established measures may offer less predictive validity for objective psychological outcomes, and suggest that scientists and practitioners are justified in using one-item measures if their proposition of face validity is sound (Ekkekakis, 2013).

Moreover, research points out on an important advantage for the use of single-item measures during demanding experimental procedures, when it is desirable to obtain an immediate and dependable answer (Ekkekakis & Petruzzello, 2000). Specifically, well constructed single-item scales are easy and convenient to administer, easy to complete, and can be highly relevant. The studies comprising this thesis are experimental in nature, and the principal aim was to examine the construct of core affect, therefore the use of single-item measures is appropriate across the studies.

3.2.1 Affect

The construct that is examined throughout this thesis is core affect (Russell, 2003; Russell & Feldman Barrett, 1999). Core affect is identified as being the most elementary consciously accessible affective feelings, and is considered as the most general construct in the hierarchy of affective constructs, being broader than mood and emotion (Russell & Feldman Barrett, 1999). The principal aim of the studies is to detect a change in affective feelings due to experimental manipulation and the presence of contextual cues (Study 1), as well as how affective states fluctuate over time (Study 2 and 3); therefore the use of a measure that captures changes is required to reflect the global domain of content as opposed to distinct states. In light of contemporary research (Ekkekakis, 2013; Russell, 2005) it is advocated that core affect is best conceptualized as a domain defined by a set of basic dimensions, therefore the approach to measurement is based on the circumplex model (Feldman Barrett & Russell, 2009).

The circumplex model targets the most elementary consciously accessible affective feelings that are not cognitive or reflective (Ekkekakis & Petruzzello; Russell, 1980). The model is based on the idea that affective space is defined by two orthogonal and bipolar dimensions, namely affective valence and perceived activation. The various

affective states are conceived as combinations of these two basic ingredients to different degrees. This approach has been selected because it was shown to be the most suitable when studies aim to explore the effects of a more general manipulation. It is important to note however, that this approach lacks the high degree of specificity that can be afforded by the distinct-states approach; specifically, the dimensional approach cannot make differentiations between whether a participant feels anxious or tense, and whether he or she felt enthusiastic or exhilarated. Instead, the dimensional model offers an encompassing and balanced perspective that captures the essence of most major changes in affective experience while requiring the assessment of no more than two constructs. Research has shown that bipolar scales are more appropriate than independent measures for the assessment of core affect and particularly in relation to pleasure-displeasure (Ekkekakis 2013). This position is reason in that individuals have an equal chance to report that they are experiencing pleasant or unpleasant state.

Further, Fontaine, Scherer, Roesch, and Ellsworth (2007) suggest that "the optimal number of dimensions to be included in a study depends on the question the researcher is asking" (p. 1052). Hence the two principal research questions in this thesis were examining: i) the effects of contextual cues on affective responses to exercise (study 1); and ii) how affective states fluctuate over time (Study 2 and 3). Therefore, one dimension (valence) and two dimensions (valence and arousal) were selected respectively.

Feeling Scale (FS; Hardy & Rejeski, 1989). Is an 11-point bipolar scale ranging from -5 to +5. Anchors are provided at zero ("Neutral") and at all odd integers, ranging from "Very Bad" (-5) to "Very Good" (+5). The authors of the scale suggest that instead of dealing with various categories of emotion (e.g., anger, joy, anxiety or vigor), the scale

was designed to evaluate the core of emotions: pleasure/displeasure. Thus this scale is desirable to detect changes in core affect that may occur during exercise.

The Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985) is one of the scales of the Telic State Measure (Svebak & Murgatroyd, 1985). It was originally developed as a measure of the construct of felt arousal in the context of reversal theory. It is a 6-point, single-item scale, ranging from 1 to 6, with anchors only at 1 ("Low Arousal") and 6 ("High Arousal"). The concept of perceived arousal has been found to be ambiguous to many participants in previous research (e.g., Ekkekakis & Petruzzello, 2002), therefore it is recommended that special care should be taken to ensure that participants understand the concept. In study 2 and 3, where perceived arousal was measured, the studies' participants were informed of the meaning of the concept and additional tutoring was given where a principal researcher stated, "Perceived arousal is a distinct concept to pleasure-displeasure in a way that a person in a state of high activation may experience either a pleasasnt state (e.g., excitement) or an unpleasant state (e.g., tension)." After the explanation participants were asked to generate examples of high and low activation to ensure that they comprehended the concept. The two scales, the FS and the FAS are advantageous to use together because of the difference in the format (i.e., the number of anchors and response options); using two different formats generally strengthens discriminant validity by forcing respondents to consider their answers independently for each scale (Ekkekakis, 2013).

3.2.2 Rates of Perceived Exertion

Perceived exertion. The Borg 6–20 Rating of Perceived Exertion scale (Borg, 1998) was used to assess whole-body ratings of perceived exertion (RPE). Participants stated the

number that reflected how hard the exercise felt on a 6–20 scale, ranging from no exertion at all (6) through somewhat hard (13) to maximal exertion (20). In line with recommendations (Borg, 1998), participants were given standardized instruction on how to use the scale and had time to practice during the familiarization session.

3.3 Idiographic analysis

Idiographic analysis, when compared to aggregated analysis, provides a more in-depth understanding of individuals' responses; it illustrates all changes that occur at the individual level. When measuring affective responses to exercise this factor was shown to be particularly important because of the abundant variability in affective responses to exercise between individuals (e.g., Ekkekakis, 2013). Specifically, previous studies have shown that aggregated analysis may fail to detect changes if a segment of a sample responds positively (positive affective valence), while another responds negatively (negative affective valence); thus resulting in compressed scores and in some cases a failure to find a meaningful effect (e.g., Ekkekakis, 2013; Ekkekakis, Hall, & Petruzzello, 2005). Considering this important consideration, idiographic analysis was applied to all of the studies comprising the thesis in order to facilitate the potential detection of changes occurring at the individual level; this level of analysis also complements the aggregated level of analyses. Specifically, in study 1 the idiographic analysis is comprised of affective valence (FS), motivation and perceived effort (RPE) variables during the two study conditions (i.e., experimental and control). In the study 2 and 3 of this thesis, individuals' affective responses were plotted on Circumplex space figures including affective valence (FS) and perceived activation (FAS) for both low and high intensity experimental conditions and supplemented by individuals' global affective evaluation.

4. Study 1: The Influence of Ecologically Valid Environmental Cues on Affect, Motivation, and Perceived Effort During Self-Paced Exercise

4.1 Introduction

A major practical issue in health promotion initiatives relates to the maintenance of regular exercise. A report from the World Health Organization (WHO, 2013) revealed that at least 60% of individuals in developed or developing countries are not sufficiently active to receive the health benefits associated with physical activity. Research examining exercise adherence has identified a number of contributing factors and barriers for sustained participation (Biddle & Fuchs, 2009; Netz, Zeev, Arnon, & Tenenbaum 2008; Sallis, Prochalska, & Taylor, 2000); more recently, the pleasant feeling derived from exercise participation has been highlighted as one of the central factors for successful maintenance of exercise programs (Ekkekakis, Hargreaves, & Parfitt, 2013; Helfer, Elhai, & Geers, 2015; Williams et al., 2008). Studies with a prospective design have revealed that participants who responded to a physical task more favourably (i.e., with a more pleasant evaluation), exhibited a stronger relationship between intentions and subsequent exercise behaviour (Kwan and Bryan, 2010) and were more likely to engage in exercise behaviour at 6 and 12 months in time (Williams, et al., 2008). Moreover, studies have found that pleasant affect is not only an outcome and associate of a positive exercise experience, but it can also act as a motivator for adherence to the exercise regimen (Catellier & Yang, 2013; Conroy, Hyde, Doerksen, & Ribeiro, 2010; Lind, Welch, & Eekkekakis, 2009). These findings are in line with the hedonic principle which suggests that people are driven to experience pleasant emotions, and as a consequence tend to engage in activities that are associated with pleasant affect rather than ones that result in an unpleasant affective experience (Diener & Lucas, 1999; Kahneman, 2003).

An underpinning factor influencing the amount of pleasantness experienced from exercise is the intensity by which it is undertaken (Ekkekakis, Hall, & Petruzzello, 2004).

The dual-mode model (DMM) proposed by Ekkekakis (2003) outlines that inter and intra individual variability in affective responses is moderated by exercise intensity. Specifically, the model explains that at low and moderate exercise intensities (i.e., below and at the level of an individual's Ventilation Threshold; VT) where there is no threat to the homeostatic system, affective responses are generated through cognitive appraisal. Cognitive appraisal in turn has been shown to primarily involve perceived control, self-efficacy and the social context (e.g., Rose & Parfitt, 2008). Once exercise intensity increases beyond VT it becomes too demanding to maintain a physiological steady state; the associated cognitive appraisal becomes dominated by interoceptive cues that reduce pleasant affective responses and induce unpleasant affect (Ekkakakis, Hall, & Petruzzello, 2005). Further, Williams and colleagues (2008) suggested that maximizing positive affective responses while minimizing perceived exertion may be an effective strategy to enhance adherence to physical activity programs. This account is coherent with results from study by Vazou-Ekkekakis and Ekkekkakis (2009) which concluded that sense of autonomy associated with self-selected exercise intensity promotes enhanced feeling states and perceptual responses. In line with this proposal, the use of self-selected exercise intensity protocols are more likely to increase positive affective and perceptual responses than a pre-determined, imposed intensity (Ekkekakis, Parfitt, & Petruzzello, 2011; Parfitt & Hughes, 2009).

In addition to exercise intensity, the exercise environment has also been shown to substantially influence the amount of positive affect derived from exercise (Pennebaker & Lightner, 1980; Rose & Parfitt, 2008). Specifically, it was suggested that the features of the exercise environment impact affective states by influencing self-perceptions and one's evaluations of exercise (Ginis, Jung, & Gauvin, 2003; Prichard & Tiggemann,

2010; Pridgeon & Grogan, 2012). Research examining differences in reported affective responses to exercise undertaken in laboratories vs. outdoor environments found support for these prepositions by revealing systematic increases in affect when individuals exercised in natural outdoor settings (DaSilva, et al., 2011; Focht, 2009; LaCaille, Masters, & Heath, 2004). Notably, the intensity set for the participants in these studies was based on self-selected protocols in aim to optimize affective responses among individuals. Potential explanations for the differences in responses to exercise in varied settings suggested firstly, that hence the selected intensity was low to moderate based on individuals' standards it is likely that individuals sourced their affect from cognitive appraisal (Ekkekkakis, et al., 2008) which in natural setting is seized by more robust stimuli when compared to a laboratory setting. Secondly, the perceptual cues utilized during an outdoor run may have contributed to a greater dissociative attentional focus (DaSilva et al., 2011; Morgan, 1978) and subsequently lower perception of effort (Tenenbaum, 2001) which in a result elevates affective states (Parfitt, Eston, & Connolly, 1996).

A related line of research exploring the influence of the exercise environment has studied specific features of the environment, including mirrors (Ginis, et al., 2003; Prichard and Tiggemann, 2010) and perceived "atmosphere" in a gym (Pridgeon and Grogan, 2012). Studies examining the presence of mirrors in an exercise environment suggest that mirrors generally have a deleterious effect on participants' feeling states and self-efficacy (Prichard & Tiggemann, 2010; Walton & Finkenberg, 2002). Pridgeon and Grogan (2012) examined underlying reasons for exercise adherence and dropout using a qualitative approach revealing that one of the key elements contributing to dropout for both genders was a detectable hypermasculine culture that created a feeling of distance

and disassociation from other exercisers. Another connected line of research examined in a laboratory setting the effect of printed media exposure on affective states and body dissatisfaction (Hausenblas, et al., 2004). Specifically, the study examined how viewing of an ideal body impact women's affective states, recommending that acute exposure, especially for those that are more dissatisfied with their body, is apt to lower affective states during exposure, with the effect being impactful for up to two hours after the media exposure. These results are consistent with a recent meta-analytic study which showed that exposure to thin and muscular ideal bodies is related with body dissatisfaction, impaired mood and elevated risk of eating disorder behaviour (Hausenblas, et al., 2013).

The impact of contextual cues on affect in exercise settings has also been examined in line with underpinning dual system models. For example, according to the reflective impulsive model by Strack and Deutsch (2004), reflective evaluation which relies upon deliberate activation of self-regulatory resources is closely interrelated with impulsive evaluation, which in turn arise from associative clusters that are present in memory (Antoniewicz & Brand, 2014). Such automatic evaluation can manifest a sudden experience of feelings of pleasure or displeasure (Bluemke, et al., 2010) and usually are evoked by a cue that triggers an evaluative impulse. Importantly, the automatic system of evaluation can dominate the reflective evaluation when there is lack of motivation to ponder or there is limited time to engage in the evaluative processes. In exercise settings the outcome of such domination may be transformed to the formation of an unpleasant feeling which, when associated with exercise, may exhibit as being inappropriate and not meeting one's needs (Antoniewicz & Brand, 2014).

Moreover, previous studies have highlighted that individuals are driven to exercise by different motives; specifically, some individuals exercise to enhance their

appearance or for health and fitness outcomes, whilst others exercise as an opportunity for social interactions, to experience feelings of competence, or for inherent enjoyment (Ingledew & Markland, 2008; Jonason, 2007; Ryan, et al., 1997). Previous research has highlighted that improving one's appearance and improving one's health are the most frequently identified motives of regular exercisers (Vartanian, et al., 2012). Importantly, depending on an individual's motive for exercise their perception of the exercise setting and attention are likely to be influenced by different contextual cues (Siemer, et al., 2007). It is possible that those individuals, who exercise for appearance motives may perceive the exercise setting differently than those that exercise for health reasons. This is proposed in consideration of an individual's perception, which is determined by mechanisms of attention which in turn tend to be selective and oriented towards the elements of the environment that are meaningful to the individual (Tenenbaum, 2003). A number of studies support this proposal by demonstrating that affective responses are accentuated when personally relevant scenes are imagined (e.g., Blanchfield, Hardy, & Marcora, 2014).

Despite the substantial evidence demonstrating that the exercise setting plays a central role in how one experiences and adheres to exercise, there are no studies that have experimentally investigated how the particular features of ecologically valid exercise environment impact upon the evaluation of exercise related affect and motivation. Taking into consideration the perceptual differences amongst individuals and the different motives for exercise they possess, there is substantial conjecture that the exercise environment will induce diverse individual affective and perceptual responses. Furthermore, in consideration of the external environment comprising the exercise setting, and the increased commercialization of fitness centers (Black, 2008; Marketing

online source), the environment surrounding the exerciser is a plausible location for marketing health and fitness related products (e.g., fitness classes, diet supplements, sport drinks; Prichard & Tiggemann, 2010). In particular, advertisements in the form of large posters provide salient messages that are created to cogently market the products directly to the targeted group (Golberg & Gunasti, 2007; Thompson & Heinberg, 1999; Williams & Page, 2011). In a gym, these promotional materials often use persuasive messages and images including lean and muscular bodies which in turn are apt to influence cognitive appraisal and affective states of the individual exerciser (Henderson, 2003). According to the aforementioned literature these images might have a differential impact on exercise participants' motivation and affect depending on individuals' motives to exercise. To our knowledge no study has examined this hypothesis.

In summary, the purpose of the present study was to examine whether ecologically valid environmental cues would influence individuals' perceptual responses to exercise during self-paced exercise. Based upon previous research, the first hypothesis anticipated that there would be a change in affect, motivation and perceived effort across the experimental conditions. The second hypothesis was that there would be a difference in response to exercise between those that report higher scores on the appearance motive for exercise and individuals reporting lower scores on the appearance motive measure. Specifically, it was hypothesized that those individuals who associate with the appearance motive, when viewing contextual cues reflecting the appearance motive would report more positive affect and motivation than those that do not associate themselves with the appearance motive. In contrast, those individuals who consider themselves to primarily exercise for fitness and health reasons are hypothesized to not be affected by contextual cues reflecting the appearance motive. Further we hypothesized that perceived effort would remain unchanged across the two conditions.

4.2 Method

4.2.1 Participants and Design

Participants were 36 individuals (M_{age} = 24.11, *SD* = 3.21, males = 15, females = 21) who volunteered to participate in an unpaid study. The sample included both post-secondary students (*N* = 20) and non-students (*N* = 16). To be eligible for the study, participants had to meet the following criteria: (a) had no health problems that precluded participating in low-to-moderate intensity exercise; (b) at the time of the data collection were at the age of 18 or above; (c) held a valid membership to the fitness center where the study took place. Ethical approval was obtained from the ethics committee from the University where the study took place.

4.2.2 Materials

Motivational cues were identified through a three phase pilot study conducted at a British university. First, a number of pictures (*N* = 45) presenting themes related to exercising and healthy habits were selected from an image bank from a photographic agency. Next, four sport and exercise psychology professionals (e.g., University Lecturers of sport and exercise psychology) selected 25 pictures reflecting two principal motives for exercising (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997), the appearance (*N*= 12) and the health and fitness (*N* = 13) motives. The 25 pictures were classified according to the frequency with which they were selected by the sport and exercise psychology professionals. To further test content validity the identified pictures were included in the pilot questionnaire (See Appendix E) that was distributed to psychology and sport science undergraduate and postgraduate students (M_{age} = 22.8 years, *SD* = 1.64, *N* = 24) at the University campus (Dillman, 1978). Previous research has demonstrated there are significant differences in how genders perceive what is an attractive body (Jonason, 2007); therefore, two separate

groups were formed, a group of females and males who were presented with two distinct sets of the pictures to be evaluated. Each gender group evaluated pictures presenting their own gender. The questionnaire asked participants: *"In your opinion, how well do the pictures represent the following motives for exercise?"*. Individuals were provided with the five motives from the Motives for Physical Activity Measure – Revised (MPAM-R; Ryan, Frederick, Lepes, Rubio, and Sheldon, (1997) attached to a 7 point Likert scale ranging from 1 *(not at all)* to 7 *(very much)* and presented together with the selected pictures. The results of the pilot study showed that the pictures representing the appearance motive were distinctly selected based on the high scores on the appearance motive Likert scale scores (M = 6.16, SD = .89). However, the fitness motive did not reach congruent answers (M = 3.4, SD = .89) and there was a considerable variability among both genders in perception of the health motive. In a follow-up pilot study a larger number of pictures representing health motive was selected. A group of postgraduate students (Male = 6, Female = 7, M_{age} = 23.9 years, SD = .45) viewed a series of pictures separately and provided a score on how well the pictures represented 5 motives for exercise using a Likert scale from 1 *(not al all)* to 7 *(very much)*. Five pictures were selected for males and females (See Appendix H and I) which attained the highest frequency and were subsequently presented together to be evaluated again as a whole poster. Results from the follow-up study haven't revealed a cohesive trend of perception of health and fitness motive pictures and in a consequence the condition of health motive was discarded from further study. The pictures selected for the appearance motive were used in the production of two large posters (841cm × 1189cm) one including images of males (n = 4) and other with pictures of females (n = 5) (see figure 1 and 2) for the images used in the poster (See Appendix F and G).

4.2.3 Measures

Demographics. Participants reported their age, gender, occupation, and exercise history (i.e., how long they have been exercising for and how frequently they exercise/per week). All participants were asymptomatic of illness or disease and free from acute or chronic injury, as established by the American College of Sports Medicine (ACSM 2009) and assessed with a health check questionnaire.

Motives for exercise. Motives for exercise were measured with an exercise motivation scale (MPAM-R; Ryan et al., 1997; See Appendix D) which is a 30-item measure of motives for physical activity participation. Responses to each item were recorded on a 7-point scale ranging from 1 (*not at all true for me*) to 7 (*very true for me*). The scale contains five motive subscales, namely, competence–challenge motives (e.g., ''I like physical challenges''), appearance motives (e.g., ''I want to improve my appearance''), social motives (e.g., ''I want to meet new people''), fitness–health motives (e.g., ''I want to maintain my physical strength'') and enjoyment–interest motives (e.g., ''I enjoy this activity''). This instrument has demonstrated satisfactory reliability for each subscale with Cronbach's α ranging from .78 to .92 (Ryan et al., 1997).

Affective valence. The Feeling Scale (FS; Hardy and Rejeski, 1989; See Appendix B) was used to measure pleasure-displeasure affective valence. FS is an 11 point bipolar measurement scale of "basic" or "core" affective valence (pleasure-displeasure) ranging from +5 *(I feel very good)* to -5 *(I feel very bad)*. The FS has been used in previous exercise studies and has exhibited satisfactory convergent and discriminant validity (DaSilva et al., 2011). The affective valence measured by FS is a fundamental component of the circumplex model by Russell (1980), which incorporates affective valence and

activation space. In the present study, emphasis was placed on affective valence because this dimension has been considered of greatest interest in the context of examining the possible causal link between exercise intensity and adherence (Kilpatrick, et al., 2007). Affective valence has been recommended for measuring pleasure/displeasure component of affective experience (Welch, Hulley, & Beauchamp, 2010; Schneider, Dunn, & Cooper, 2009; Stych & Pafritt, 2011)

Ratings of Perceived Exertion (RPE). The whole-body rating of perceived exertion was assessed with the 15-point single-item Rating of Perceived Exertion (RPE; Borg, 1998; See Appendix J), which ranges from 6 (*no exertion at all*) to 20 (*maximal exertion*). Borg (1998) has provided extensive reliability and validity information on the RPE.

Motivation. Motivation was measured by a single item scale wording: "How motivated did you feel to run on the treadmill?". A single item was used as opposed to a multi-item scale to capture the reflective, immediate response that is not distorted by cognitive processes and is not biased by social desirability, but rather is based on the feelings associated with motivational properties (Hsee & Hastie, 2006; Slawinska, et al., 2015).

4.2.4 Procedure

The study was advertised via a generic University e-mail including sport science and psychology undergraduate and graduate students, and recruited individuals who were active members in a fitness centre. Individuals agreeing to participate provided signed informed consent in accordance with the University's guidelines (See Appendix A) prior to the study taking place. Via an on-line questionnaire hosted on surveymonkey.com the baseline measures were collected regarding demographics, exercise history and exercise

motives (MPAM-R). Next, participants were asked to select a convenient date and time and confirm their participation by replying to the email. During the orientation session, participants attended the fitness center and were familiarized with the process of self-selecting exercise intensity. Each participant was given the following instructions: " Select an exercise intensity that you prefer and can sustain for 20 min and that you would feel happy to do regularly" (Parfitt, et al., 2000). Next, participants were briefed on the task and familiarized with the equipment. At an agreed time, individuals arrived at the gym and were provided time to warm-up (3 minutes). When the warm up time finished, participants were asked to commence a running session on a treadmill for twenty consecutive minutes at a self-selected pace of a moderate intensity. Individuals were advised that they could modify the pace or the grade of the treadmill every 2 minutes if desired. Immediately after the performance individuals were asked to fill in the questionnaires on affective responses, motivation and perceived effort. Once completed, the questionnaires were collected and participants were scheduled for another testing session in the following days. All participants were involved in two trials, one experimental condition (priming with motivational cues) and the control condition without any cues, the order of the presentation of the conditions was counterbalanced. Exercise trials were scheduled at the same time of the day, performed on the same treadmill and separated by at least 24 hrs. In the experimental condition motivational cues were presented on two posters that were A0 size (841cm × 1189cm), hung approximately one to two meters away from the treadmill where the individuals performed the task. The posters were hung prior to the arrival of the participant; the presence of the posters and the intended aim of the posters were not mentioned to participants until the study was completed (see image for an example of the testing setting). In the control condition the

test setting was exactly the same as the experimental condition but without the two posters. After the exercise trials participants were debriefed (See Appendix K).

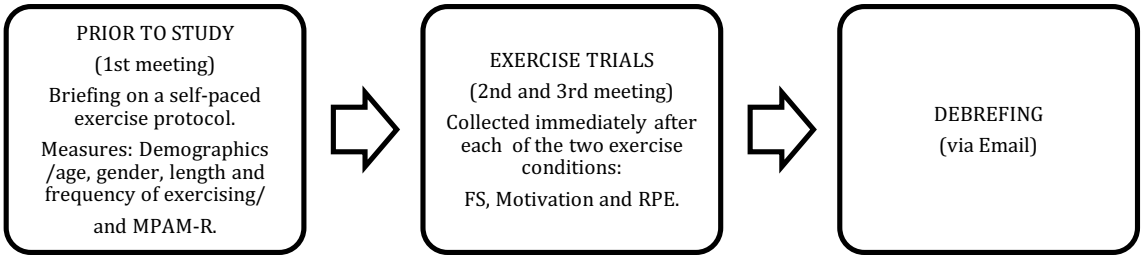


Figure 1.1. Schematic of the exercise protocol.

Motives for exercise data reduction. For the purpose of this study, from the five subscales of the MPAM-R, one subscale representing the appearance motive was further included for analyses. Based on a median score, participants were assigned to a low or a high group (*Mdn* = 4.12 *SD* = .58) resulting with a group of 18 females and a group of 18 males.

4.3 Results

Sample characteristics

Results showed that 61.1% of participants reported to have been exercising regularly for 6 months or longer whereas 5.6 % reported to have initiated exercising regularly within the past month. 83.4% of participants reported exercising at a moderate intensity at least 2 days a week, while 13.9% said that they exercise once or less a week. No gender differences were found in the length of exercising ($F(1, 34) = .87$, $p = .36$) or exercise frequency ($F(1, 34) = .28$, $p = .60$). No gender differences were also found in reported affect $F(1, 34) = .10$, $p = .75$, *partial* $\eta^2 = .01$, motivation $F(1, 34) = .09$, $p = .77$, *partial* $\eta^2 = .01$, or perceived effort $F(1, 34) = .27$, $p = .60$, *partial* $\eta^2 = .01$.

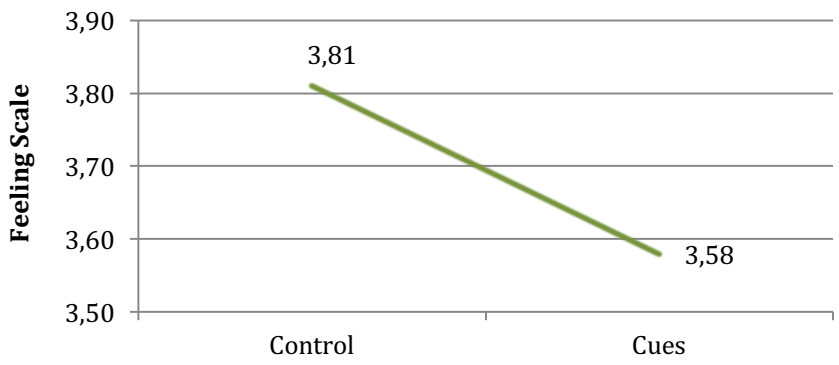


Figure 1.2. Feelings (FS) across the conditions on an aggregated level of analysis.

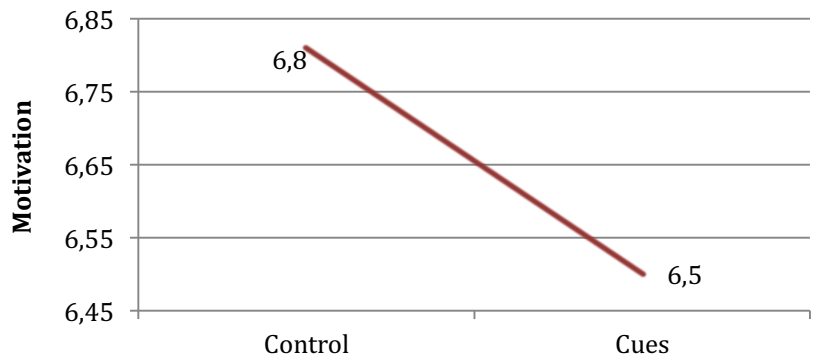


Figure 1.3. Motivation across the conditions on an aggregated level of analysis.

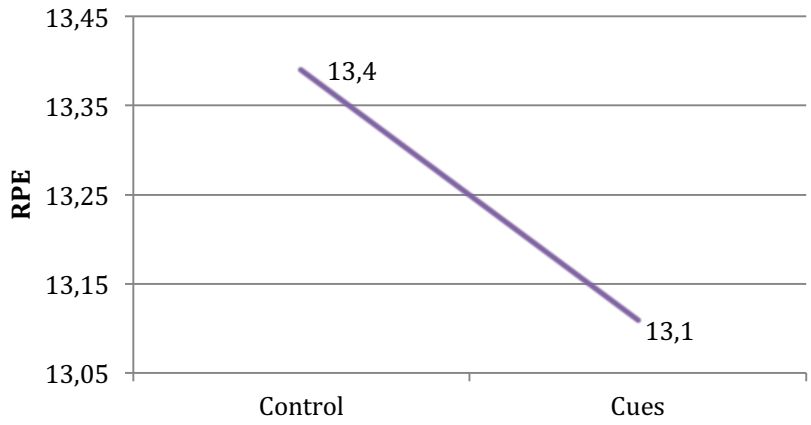


Figure 1.4. Analysis of Perceived effort (RPE) variable across the conditions on aggregated level of analysis.

Idiographic analysis

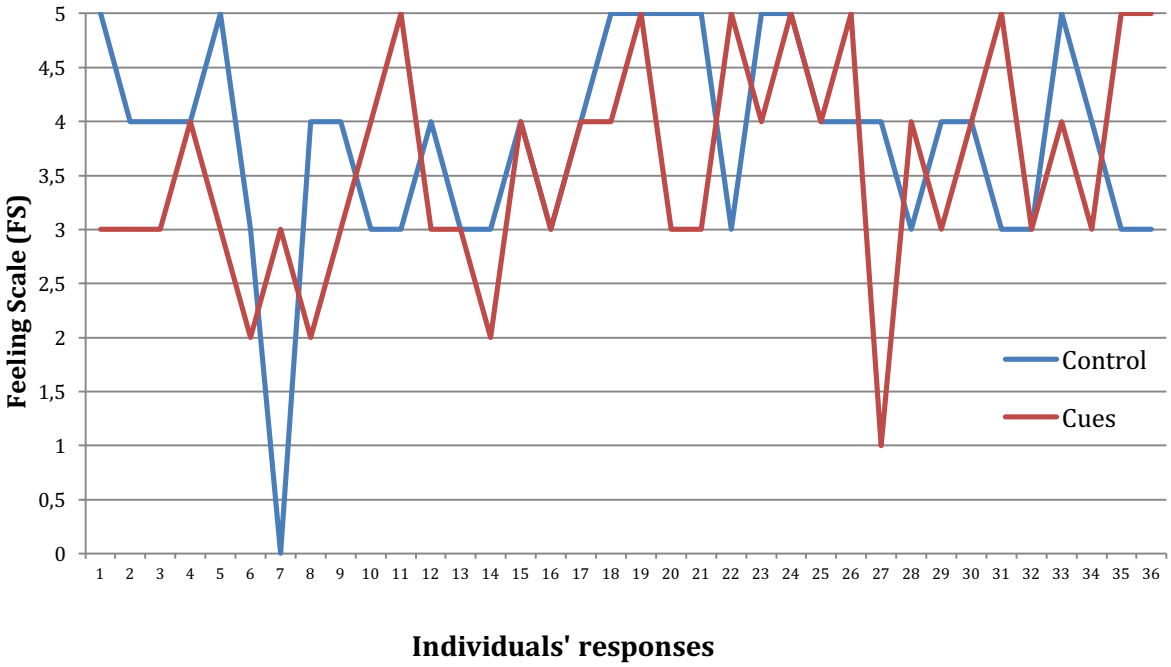


Figure 1.5. Individuals' based analysis of FS variable across the conditions.

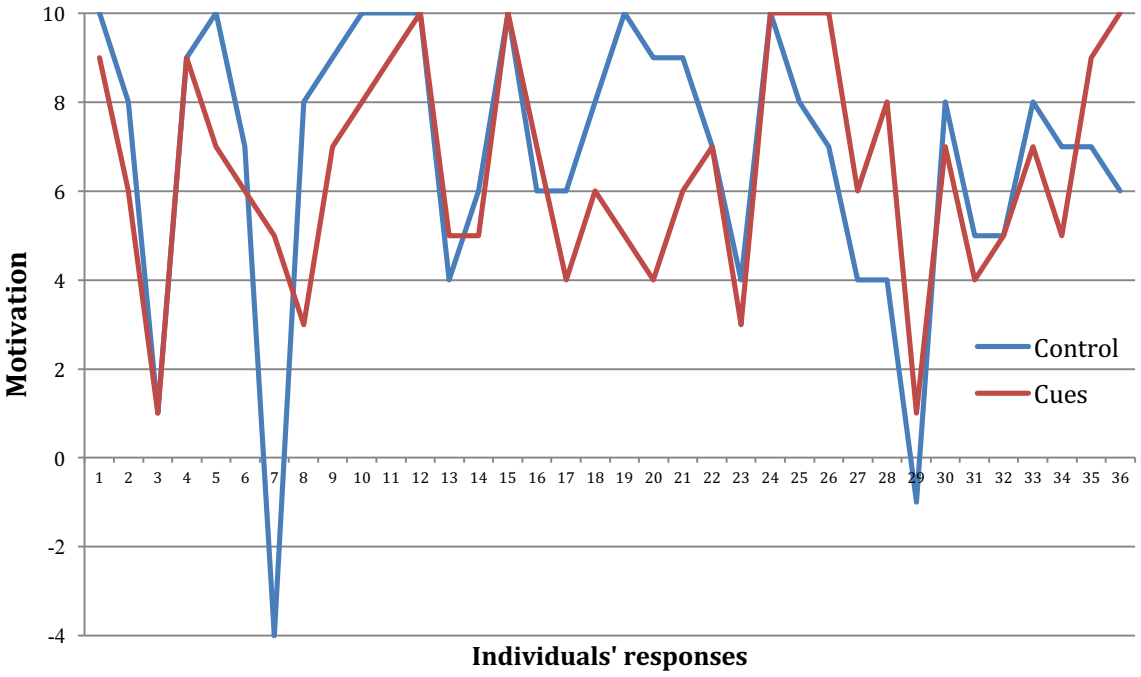


Figure 1.6. Individuals' based analysis of Motivation variable across the conditions.

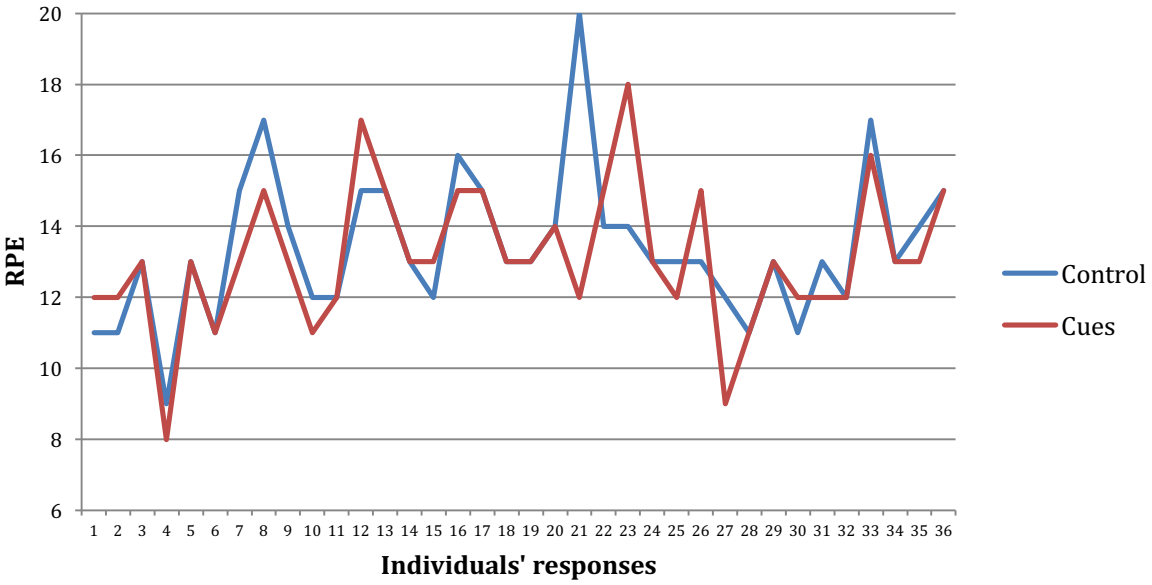


Figure 1.7. Individuals' based analysis of Perceived exertion (RPE) variable across the conditions.

Manipulation check

The mean levels and standard deviation values of affect, motivation and perceived effort are shown in Table 1.1.

Table 1.1.
Means and SD for Affect, Motivation, and Perceived Effort in Control and Experimental Condition

Condition	Feelings States *Mean (SD)*	Motivation *Mean (SD)*	Perceived Effort *Mean (SD)*
Control	3.80 (1.00)	6.81 (3.21)	13.38 (2.07)
Experimental (Motivational Cues)	3.58 (1.02)	6.50 (2.52)	13.11 (1.99)

Repeated measure ANOVAs showed no main effect of motivational cues on affect $F(1, 34) = .99, p = .33, \eta^2 = .03$, motivation $F(1, 34) = .62, p = .87, \eta^2 = .02$, or perceived effort $F(1, 34) = .82, p = .37, \eta^2 = .02$. Importantly however, there was a significant interaction

between motives for exercise and affect $F(1, 34) = 4.99$, $p < .05$, *partial* $\eta^2 = .13$, and motivation $F(1, 34) = 14.45$, $p < .01$, *partial* $\eta^2 = .30$ but not for the perceived effort $F(1, 34) = .03$, $p = .86$, *partial* $\eta^2 = .00$. Mean values and standard deviation values are displayed in Table 1.2.

Table 1.2
Means and SD for Interactions Between Motives for Exercise and Effect, Motivation, and Perceived Effort due to Experimental Manipulation

Appearance Motive	Condition	Feelings States *Mean (SD)*	Motivation *Mean (SD)*	Perceived Effort *Mean (SD)*
Low	Control	4.11 (.76)	6.89 (.64)	13.94 (2.24)
	Experimental (Motivational Cues)	3.38 (.98)	5.11 (2.37)	13.61 (1.88)
High	Control	3.5 (1.15)	6.72 (3.46)	12.88 (1.79)
	Experimental (Motivational Cues)	3.77 (1.06)	7.89 (1.84)	12.61 (2.03)

Further, the interaction effects showed that individuals who described themselves as principally exercising for the appearance motive (scored high on appearance subscale) when run under the experimental condition with visible cues reported higher levels of motivation and affect when compared to a control condition without where exercise was performed without the cues. Individuals who stated that the appearance motive for exercise is not important for them (scored low on an appearance subscale) were affected adversely by the presented cues reporting lower levels of motivation and affect. Perceived effort maintained unchanged regardless of the group.

Post hoc ANOVA analyses that compared means from low and high appearance groups showed significant difference in motivation in experimental condition $F(1,35) = 15.38$, $p < .001$ and a difference approaching conventional statistical level of significance in feeling states during a control condition $F(1,35) = 3.54$, $p = .068$ (Figure 1.8 and Figure 1.9).

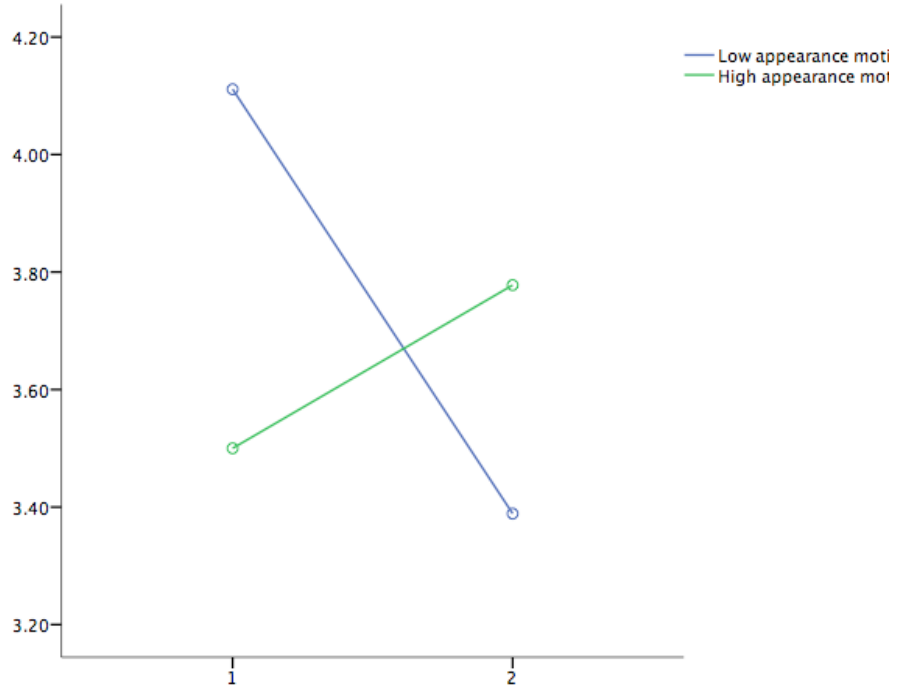


Figure 1.8. Feeling states across the conditions for high and low appearance groups.

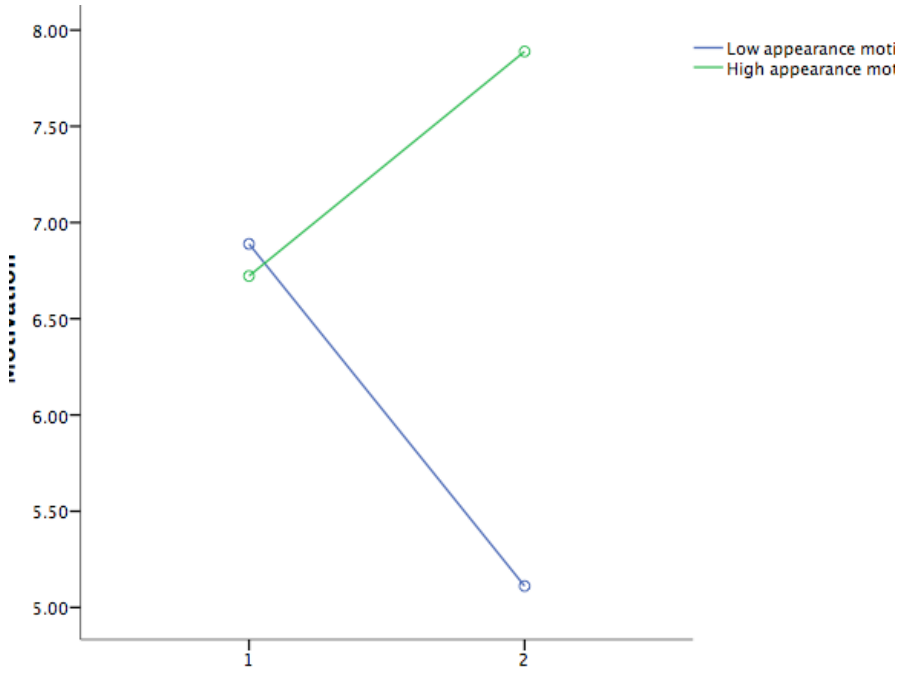


Figure 1.9. Motivation across the conditions for high and low appearance groups.

4.4 Discussion

The purpose of the present study was to examine whether cues in an ecologically valid exercise environment would influence individuals' affective responses to exercise and their motivation during exercise. In doing so, the relationships between motives for exercise and exercise related affect, and motives for exercise and motivation were examined.

It emerged that motivational environmental cues were found to impact upon feeling states and motivation in an upward trend when they were self-descriptive, whereas when motivational cues were non-self-descriptive they lowered participants' exercise related affect and motivation. That is, when the motivational environmental cue aligned with the individual's primary motive for exercise (i.e., appearance) there were positive effects upon feeling states induced by exercise and motivation during exercise. However, for individuals who did not exercise for the motive of appearance, the environmental cue lowered their affective response and motivation during exercise. Importantly, the cues had no influence on motivation or affect when the results were analyzed at the whole group level.

Further, those individuals for whom motivational cues were not self-descriptive reported significantly lower motivation and affective responses than in a control condition (without primed cues). Particularly, the results revealed that the worsening in affective responses and motivation among those with low levels of appearance motive were greater than increases among those who perceived appearance motive as self-descriptive. These findings are in line with studies highlighting that a worsening in affective responses evoked by a perception of a loss are greater than improvements, due to the undesirable state conveying stronger inference (Ariely, et al., 2005; Chatzisarantis, et al., 2012; Kahneman & Tversky, 1979). In the present study individuals who faced incongruity

between primed motivational cues and their own motive for exercise, could experience a sense of loss if they interpreted the circumstances as a loss of time or a loss of energy they had invested into exercising. An applied implication arising from these findings may suggest that in order to optimize the affective and perceptual responses of exercisers, the management of a fitness center may want to select advertising materials that could be customized for their clients, or in the case of a diverse population the fitness center should aim to present messages that are neutral in their motives for physical activity to avoid undermining their clients' motivation or affective responses (Pridgeon & Grogan, 2012).

The present study's findings contribute to the understanding of affective and perceptual responses to exercise by highlighting that not only are environmental cues influential, but also how they interact with individuals' motives for exercise. The findings are in line with Siemer's, et al., (2007) study which outlined that the perception of a context is likely to be influenced by different contextual cues depending on individuals' cognitive appraisal. It is important to emphasize here that the posters were setup without participants being made aware of their presence and the exercise took place in the participants' usual gym, in a setting that was very familiar. Therefore, the impact of the primed motivational cues in this study is robust, and the effect of other cues due to their familiarity can be assuredly excluded.

Furthermore, the results of the study did not indicate any significant differences in a perception of effort between experimental and the control conditions. A number of previous studies indicate that environmental cues can influence perception of effort; individuals exercising in a natural setting perceive their effort to be lower than when exercising on a treadmill which in turn increases their perceptions of fatigue and elevates perceived effort (DaSilva, et al., 2009; Ekkekakis, 2009). In our study we asked participants to exercise on a treadmill, offering them the autonomy to self-select the

exercise intensity and associated perceptions of comfort. This method was replicated from a previous study where participants exercised at a self-selected pace in order to optimize their affective responses and to minimize perceptions of effort while performing a physical task (Ekkekakis & Vazou-Ekkekakis, 2009). Thus, it is possible that by providing participants with the opportunity to exercise at their preferred pace, the intensity of the exercise was optimal and changes in the environment caused by the experimental manipulation were not important for the evaluation of effort. Alternatively, another potential explanation as to why the perception of effort remained unchanged could be that individuals' evaluation of effort was grounded on physical cues that seemed objective (e.g., respiratory rate) and are viewed as more concrete and less susceptible to influence from the contextual motivational cues presented in the current study (LaCaille, et al., 2004).

It must be noted that during the undertaking of the present study, a number of limitations arose. First, despite the promising variability amongst participants the final sample size was relatively small, comprised of 36 participants. Future studies may consider replicating the present results including a larger number of participants to improve the validity and generalizability of the findings. One important limitation of this study was the research design; specifically, the lack of a pre-exercise measure to establish the baseline levels of affect and motivation. The design of the study was developed to maintain the highest possible ecological validity and it was important the study's measures introduced minimal disruption to participants' usual exercise routine. As a result of this trade-off, the measurement was taken only post exercise with an aim to compare individuals' affective responses between the study's two conditions. While the study's findings are informative due to the post only measurement it cannot be concluded with certainty that observed changes are due to the experimental manipulation and not to

discrepancies of baseline levels (pre-exercise affect) of the individuals. This limitation should be addressed in subsequent studies. Furthermore, for the more adequate measurement of affect, future studies may consider including additional measurement at multiple time points; in particular measures taken during exercise may help to establish the exact moment when environmental cues begin to influence participants and are integrated into their evaluation. Future research in this area may also consider examining other features of the natural environment that are likely to impact upon affective and perceptual responses to exercise.

In conclusion, the results of this study demonstrate that self-descriptive cues are an important factor in improving one's positive affect and motivation during exercise, whereas cues that are not self-descriptive may impinge upon evaluation of exercise-related affective and perceptual states. Of note, the findings of the current study highlight that aspects of the exercise environment are central to the experience of exercise as they are not evaluated separately, but are molded into a gestalt exercise experience. Thus, in order to optimize the experience of exercise, sports professionals should carefully select the advertisements on their premises such that the content is likely to connect with exercisers' motives. Future study of the exercise-affect relationship would benefit from considering other features of the environment that are likely to impact upon the affective and perceptual responses to exercise.

5. Study 2: The Recall and Anticipation of Exercise Induced Affect

5.1 Introduction

To increase understanding of the mechanisms underlying the global issue of physical inactivity (Troiano et al., 2008), contemporary research has focused on the factors that influence individuals' perceptual experience of exercise (Ekkekakis, et al., 2013; Kwan, & Bryan, 2010). Numerous studies have found that one prominent feature impacting upon individuals' perceptions is the degree of pleasant and unpleasant feeling states that occur during and immediately after exercise (Ekkekakis & Petruzzello, 1999; Hyde, et al., 2011; Reed & Ones, 2006). Further, growing evidence suggests that there is a number of factors that meaningfully impact upon affective responses to exercise, including environmental factors which are often gaudily present in the exercise context. A previous study of this thesis examined meaningful environmental cues in a within-subject design. In the study, environmental cues were selected based upon highly ecological valid images. The study found that motives for exercise are a meaningful agent that can guide how the exercise environment is perceived; in particular elements that are more or less personally meaningful can influence how pleasant exercise is perceived. In consideration of the individual variability highlighted in the first study, the subsequent program of studies was amended to focus more centrally on within individual changes. The following two studies of this thesis are focused on individuals' changes, drawing on a research framework associated with exercise-intensity-adherence, the dual mode model (DDM) that was described previously. Furthermore, the study 2 and 3 will aim at developing knowledge on how individuals' recall exercise related affect which until now has not been investigated in much detail.

Positive affect experienced during exercise has been identified as an important predictor of future exercise behaviour (Annesi, 2005; Arent, Landers, & Etrier, 2000; Helfer, et al., 2015; Kwan & Bryan, 2010; Schneider, et al., 2009; Williams, et al., 2008)

whereas experiences of discomfort or pain during physical activity are likely to lead to a discontinuation (Ekkekakis, 2003). Further, upon completion of exercise, the memory of affective responses has been suggested to reflect the exercise experience (Annesi, 2005; Williams, et al., 2008). Conversely, research examining memory processes suggests that the recall of an experience can substantially differ from the actual experience (Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Miron-Shatz, Stone, Kahneman, 2009). In light of the potential for inaccurate recall and the predictive value of affective memory in forecasting future exercise behaviour, the present study aimed to examine individuals' recall of exercise related affect over a period of two weeks.

Recently, a number of researchers have challenged the widely promoted 'feel good' effect of exercise; they suggest this purely positive message associated with exercise related affect does not accurately reflect the composite experience of exercise and can problematically raise expectations (Backhouse, e al., 2007; Ekkekakis, et al., 2008; Rose & Parfitt, 2012). Specifically, contrary to the belief that exercise makes all people feel good, studies have identified that affective responses vary over the course of the activity; affect fluctuates from positive to neutral or negative valence usually returning to a positive valence nearing a baseline level upon termination of the activity (Backhouse, et al., 2007).

One explanation for the extent of variability in affective responses relates to the intensity of the exercise. Ekkekakis and colleagues proposed the dual-mode model (DMM; Ekkekakis, 2003; Ekkekakis, & Acevedo, 2006) which outlines that when exercise intensity is below the point of the ventilation threshold (VT) individuals tend to derive more pleasure from exercise. On the other hand, if the intensity is high and exceeds an individual's VT, the exercise experience tends to generate less pleasant affect and

increase unpleasant affect. The shift in affective responses has been accounted for by the domination of interoceptive cues (e.g., pain in the leg muscles or perception of being out of breath) which are strongly associated with negative unpleasant affect (Ekkekakis, et al., 2004; Ekkekakis, et al., 2008).

A related advancement in the research of affective responses to exercise was derived from improvements in research methodology and approaches to measurement (Ekkekakis, 2013). Specifically, it was acknowledged that if affective responses to exercise are exclusively measured pre and post the exercise trial, substantial information is omitted relating to the affective experiences that occur during the bout of exercise (Ekkekakis, & Acevedo, 2006; Backhouse, et. al., 2007). Subsequent studies following this line of research highlight that when affect is measured during exercise it fluctuates to the extent that earlier pleasant ratings can decrease to reports of 'feeling bad' and reflect a change in 6 measurement points on a 10-point scale (Ekkekakis, et al., 2008).

Further, a study by Williams et. al., (2008) showed that individuals who perceived exercise as being more pleasant reported better exercise adherence at 6 and 12 months after the initial measurement in comparison with individuals that experienced less positive affect and more negative affect. Similarly, Kwan and Bryan's (2010) study demonstrated that individuals who experienced greater increases in positive affect engaged more often in voluntary exercise across a 3-month follow-up period. Kwan and Bryan proposed that the exercise adherence observed may be due to the expectation of further increases in positive affect from subsequent bouts of exercise. Hence long-term goals are more difficult to achieve (Trope, & Liberman, 2003); the anticipation of the immediate affective benefits derived from exercise may be a more salient factor contributing to individuals' judgment and decision to be physically active (Helfer, et al., 2015).

On a related note, numerous studies advocate that people often make decisions based on their affect (Baumeister, et al., 2007; Damasio, 1994; Kahneman, et al., 2003). For example, Damasio (1994) proposed that automatic affect which results in affective residue (also termed as a somatic marker) is likely to guide future behaviour even when people are not fully conscious of their affective inputs. Alternatively, Baumeister et al., (2007) advise that individuals tend to associate affect with experienced events and that these associations become a form of a feedback for on-going behavioural regulation. Baumeister and colleagues also suggested that memorised associations are important as they inform anticipatory feelings prior to the experience of the same or similar event. These feelings prepare the individual for a course of action that are either avoidant or approach oriented; specifically, if anticipatory feelings are positive the experience will most likely be approached, however if anticipatory feelings are comprised of adverse affective associations the behaviour will be directed towards avoidance.

In relation to exercise, research on affective responses has mainly focused on measurements taken during the activity and presumed that once exercise is completed the memory is formed and the evaluation of affective responses to that task remain constant over time (e.g., Williams, et al., 2008). One research line that went beyond this conventional approach and examined the differences between affective experience of exercise and the recall of experienced affect from exercise showed a great variability in individuals' responses (Hargreaves, & Stych, 2013; Miron-Shatz, et al., 2009). Specifically, Miron-Shatz and colleagues outlined that there are two distinct processes associated with memory, one process when the actual experience occurs and another how the experience is recalled in time. Authors further explain that individuals tend to remember the intensity of an experience and how it finishes instead of an average of the

entire experience. Moreover, they suggest that negative affect is more significant during recall in comparison with positive affect and it is likely to dominate the remembered experience. Another study by Hargreaves and Stych (2013) demonstrated that the recall of affective experience varies depending on how exercise finishes. Specifically, the study showed that those who finished the exercise on a positive, less vigorous note remembered the exercise as more pleasant than individuals who exercised with a higher intensity. The explanation for this bias comprises that individuals do not take the entire experience into the account rather they use salient pieces of information from which they create the composite memory of the experience.

The theoretical framework that has been used to explain these biases (Fredrickson, 2000) further suggests that the construction of a global evaluation involves both memory (recalling our feelings) and judgement processes (the meaning of those feelings) and that individuals use two distinct moments of an experience to make this global evaluation. In particular, the moments that are the most intense affective moment of the experience, and the affect that is experienced at the end of the event. This phenomenon has been termed in the literature as the *peak and end* rule. The significance of the peak and end affect in creating the global evaluation is grounded in the personal meanings that are carried by these two affective moments. The peak affect represents how pleasant or unpleasant the situation can get, but more importantly it "conveys the personal capacity necessary for achieving, enduring, or coping with that episode" (Fredrickson, 2000 p. 590). The end affect tends to denote that the situation is completed and the meaning of the situation can be evaluated with certainty. Importantly, only at the end of an event the peak can be comprehended and in consequence, the degree of personal capacity required for the experience valued.

In summary, considering the evidence presented from both exercise psychology and social cognition literature, the examination of changes in exercise related affect over time is likely to offer a potential explanation of why individuals do not adhere to exercise despite the pleasant affect derived from the activity (Backhouse et al., 2007). The present study aims to advance understanding of the links between the affective experiences of exercise, how individuals recall their affective experience, and how they anticipate feelings related to exercise. In doing so, the DMM is considered in the examination of the influence of exercise intensity (based on individuals' VT) on the recall of affect and anticipatory feelings related to exercise. Specifically, individuals' affective experiences of exercise were measured during two exercise trials (completed at either a high or a low intensity); their recall of exercise related affect was then measured across 14 days following the trials, and immediately prior to the second bout of exercise their anticipatory feelings were measured. We hypothesized in line with previous findings that the current affect experienced during low exercise intensity will be higher than during high exercise intensity. Further, we hypothesized that the memory of exercise induced affect would fluctuate over the 14 days in relation to both exercise intensity conditions with less positive affective evaluation after a high intensity exercise in comparison with a low intensity exercise. In concordance with existent findings we speculated that affective evaluation will be moderated by perceived exercise behaviour and those who perceive their exercise behaviour as higher will evaluate affective experience more positively then those who perceive their exercise behaviour as low. Finally, based on previous research we hypothesized that the recall of exercise related affect would be a better predictor of anticipatory feelings rather than the affect reported during the initial exercise trial itself.

5.2 Method

5.2.1 Participants and design

The study sample consisted of 42 adults (26 females, 16 males), $M_{age} = 29.64$, $SD = 5.69$, students ($N = 18$; 42.9%) and non-students ($N = 24$; 57.1%), who at the time of the study did not suffer from any physical injury, had no history of cardiovascular or respiratory disease and were physically capable to engage in moderate exercise (See Appendix M). Participants were recruited via a generic email as well as posters displayed on the University's campus notice boards and in one large fitness center in the UK. Upon agreement to take part in the study participants signed informed consent form. The ethical approval was gained from the University where the study took place.

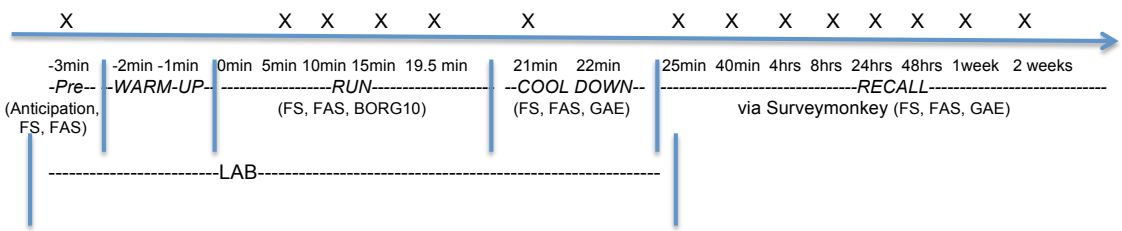


Figure 1.10. Schematic of the exercise protocol.

5.2.2 Measures

Current exercise behaviour. Current exercise behaviour was measured using the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985). LTEQ has been previously used to assess how frequently participants undertake more than 20 min of mild, moderate, and strenuous exercise during their free time in a typical week calculated by metabolic equivalents (METs; mild x 3 + moderate x 5 + strenuous x 9).

Affect. The affective valence and perceived activation dimensions of the circumplex model were assessed by two single-item scales. The affective valence dimension has been assessed by the Feeling Scale (FS; Hardy & Rejeski, 1989), which entails 11 point bipolar measurement scale of pleasure-displeasure, ranging from +5 *(I feel very good)* to -5 *(I feel very bad)*. The perceived activation dimension will be assessed by the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985) on a 6-point scale ranging from 1 *(low arousal)* to 6 *(high arousal)*.

Recall of affective experience. Recall of affective experience was measured with the Global affective evaluation scale (GAE; Schreiber & Kahneman, 2000; See Appendix Q) which has been previously used to measure the overall amount of pleasantness or unpleasantness that was experienced during exercise (Hargreaves, & Stych, 2013) using a scale ranging from -10 *(very unpleasant experience)* through 0 *(neutral experience)* to +10 *(very pleasant experience)*.

Anticipatory feelings. Anticipatory feelings were measured by a single item scale, worded: "Please rate the overall amount of pleasantness or unpleasantness you expect to feel in the upcoming exercise trial on a scale ranging from -10 *(very unpleasant experience)* through 0 *(neutral experience)* to +10 *(very pleasant experience)*. The measure was collected immediately before the exercise bout.

Perceived exertion. The Borg 6–20 Rating of Perceived Exertion scale (Borg, 1998) was used to assess whole-body ratings of perceived exertion (RPE). Participants stated the number that reflected how hard the exercise felt on a 6–20 scale, ranging from no exertion

at all (6) through somewhat hard (13) to maximal exertion (20). In line with recommendations (Borg, 1998), participants were given standardized instruction on how to use the scale and had time to practice during the familiarization session.

5.2.3 Procedures

Maximal graded treadmill test

First participants received an information sheet (See Appendix L) which explained procedure of the study. In order to determine individuals' ventilation threshold (VT), prior to the testing the measure of maximal aerobic capacity (VO_{2max}) was collected. First, age, height and weight were recorded. Next, a heart rate monitor (Polar WearLink+ Coded transmitter, Polar Electro, Kempele, Finland) was fitted to the participant's chest and a heart rate was obtained, staring with a rest value before the test commenced and then every minute into the test until the test was completed. This visit served also as a familiarisation session for using FS, FAS, RPE and GAE measures which were recorded before (FS, FS) and after the test (RPE, GAE). To obtain individuals' maximal aerobic capacity, participants competed the incremental treadmill test which involved alternating between increases in the speed and grade of a treadmill every minute until each participant terminated the test due to volitional exhaustion. The analysis of pulmonary gas exchange was recorded continuously with an online gas analyser (Oxycon Pro, Jaeger, Germany) and the gas analyser was calibrated before each test. Participants wore a close-fitting facemask connected to a triple-V sensor (Jaeger, Germany) consisting of a flow turbine and gas sampling tube. The attainment of maximal aerobic capacity was verified by at least two of the following criteria: i) a peak or plateau in oxygen consumption (changes <2 ml $\cdot kg^{-1} \cdot min^{-1}$) with increasing workload; ii) reaching age-predicted maximal heart

rate (i.e., 220 – age) and/or iii) a respiratory exchange ratio of at least 1.1. V_{O2peak} was established at the point where V_{O2} attained the highest value after reaching the criteria. The V-slope method was then used to determine individuals' VT. V_{CO2} was plotted against V_{O2} and from visual examination of the graph, VT was determined at the point where the first inconsistent increase in V_{CO2} occurred (Beaver, et al., 1986). Two investigators independently assessed the graphs and if there was disagreement, a third investigator was involved in analysis of the graphs until a consensus was reached on where the VT is positioned.

Exercise sessions

Upon arrival at the laboratory, the participants were asked to complete the battery of pre-exercise self-report measures (Anticipatory feelings, FS, FAS). Individuals were randomly assigned to one of the two exercise intensity conditions: 10% above-VT, and 20% below-VT, based on previously determined point of VT by using a web based online randomizer application (random.org). Depending on the randomization, participants were asked to run on a treadmill for 20 consecutive minutes at either high (above-VT group) or a low (below-VT group) pace. There was a two minute warm-up scheduled immediately before the exercise trial. Preliminary baseline measurements were collected prior to commencing the exercise trial; affect (FS, FAS) was recorded immediately before the task commenced, and measured repeatedly along with the measure of RPE (Borg 10) every 5 minutes for the remaining 20 minutes of the exercise task. Measures of FS and FAS were recorded a minute into the cool down, 5, and 15 minutes post exercise (Hagreaves & Stych, 2012). Participants were asked to complete the measure of GAE, 1, 5 and 15 minutes post exercise, and then at another 6 points in time, specified by a

researcher (i.e., 4 hours, 8 hours, 24 hours, 48 hours, 7 days, 14 days post exercise at the same time of day as when the exercise trial was completed) this resulted in 9 post measurement points. Participants were asked to attentively follow the instructions for the post exercise measurement by reporting their affective evaluation in a timely fashion via an online survey (surveymonkey.com). The responses were prompted by a notification sent to participants' mobile phones via text messages approximately 30 min before the designated time of the measurement. Once the two weeks have passed from the first measurement the second exercise trial was scheduled and undertaken. The second trial was completed using the same measurement protocol as detailed in the first trial. In the second exercise trial those participants who previously exercised above-VT pace now performed the below-VT condition, whereas those who performed the first trial below-VT condition exercised above-VT pace in the second trial. To reduce expectancy effects, the participants were told that they might have to run at any possible combination from a low to a relatively high intensity. Ecological momentary assessment (EMA) method was used to analyse within-subject variations in current and recalled affect in everyday life. Ecological momentary assessment refers to a category of methods that involves the collection of real-time data about current states (e.g., mood, activity) in the natural environment repeatedly over time. EMA has been successfully used in previous studies examining mood and physical activity (Hausenblas, Gauvin, Symons Dwon, & Duley, 2008; Kanning, & Schlicht, 2010).

Statistical analysis

To examine within-subject changes in current affect (FS) and recalled affective experience (GAE) over time, we used Repeated Measure ANOVAs analyses. Multiple

regression analyses were employed to examine predictive value of anticipatory feelings measured immediately before the exercise. All statistical procedures were conducted in IBM SPSS version 20 statistical software.

5.3 Results

Collected data from post exercise measurement points showed that a number of participants failed to complete all of the post exercise survey over the course of 14 days. This incompletion resulted with reduced number of participants considered by the analysing software (IBM SPSS 20) which totalled 27 therefore the data from 13 participants (32.5%) was omitted due to one or more missed measurement point. To resolve the missing data issue, a maximum likelihood estimation using the expectation maximization algorithm was employed to estimate and impute missing data based on the available responses. That method has been previously used in longitudinal studies in an exercise context (Helfer, et al., 2015). In order to avoid estimating data based on inadequate information, participants were excluded if they were missing more than 40% of the follow-up surveys. The data (GAE, FS, FAS) from two experimental conditions (below VT; and above VT) were included in the estimation algorithm as predictors of missing values, and estimates were constructed using IBM SPSS 20's software and preceded by applying the Missing Value Analysis function.

Current affect

Repeated measures ANOVA showed significant changes in current affect over time during and after low intensity exercise ($F(13, 38) = 6.85$, $p < .001$, $\eta^2 = .15$) and high intensity exercise ($F(13, 38) = 7.49$, $p < .001$, $\eta^2 = .16$). Figure 1.11 illustrate patterns of

changes prior, during and after the low and high exercise intensity respectively.

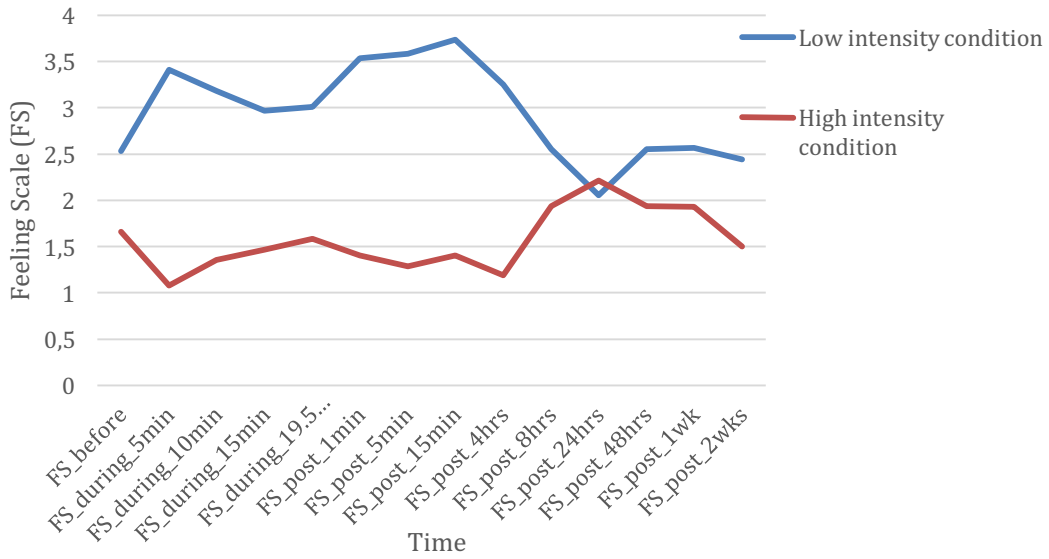


Figure 1.11. Changes in feelings states (FS) prior, during and after low and high exercise intensity – analysis on an aggregated level.

Recall of affective experience

The descriptive data on recall of affective experience is displayed in Table 1.3.

Table 1.3
Descriptive Statistics of Recall of Affective Experience (GAE).

Time	1 min post	5 min post	15 min post	4 hrs post	8 hrs post	24 hrs post	48 hrs post	1wk post	2 wks post
Low intensity *M* (*SD*)	6 (3.01)	5.69 (3.30)	6.28 (3.11)	6.30 (2.86)	6.29 (3.16)	5.10** (3.79)	5.58 (4.06)	6.44 (3.20)	5.77 (3.14)
High intensity *M* (*SD*)	3.1 (4.37)	3.56 (3.39)	2.82 (5.10)	3.07 (4.97)	2.71 (5.16)	1.97* (5.04)	2.64 (5.18)	2.77 (4.64)	3.54 (4.98)

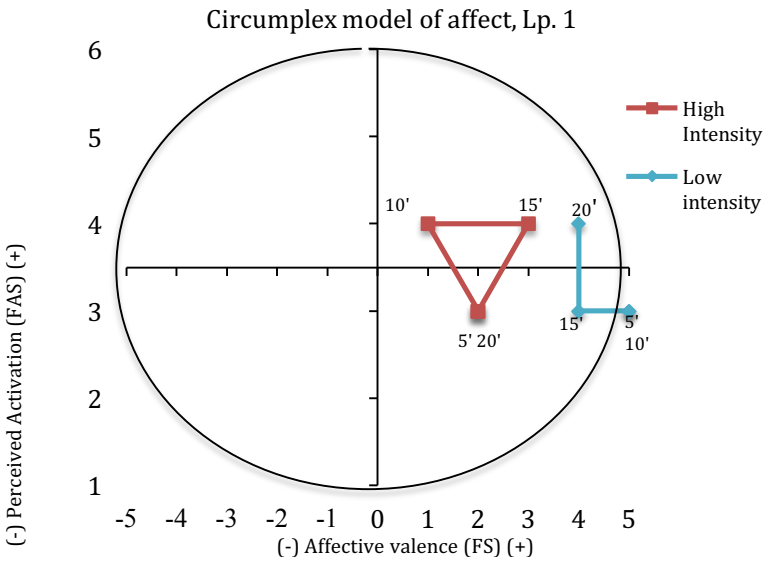
** $p < .01$, * $p < .05$

Results show that the affective valence recalled from exercise fluctuated in post exercise evaluation. The repeated measure ANOVAs indicated significant changes in recalled

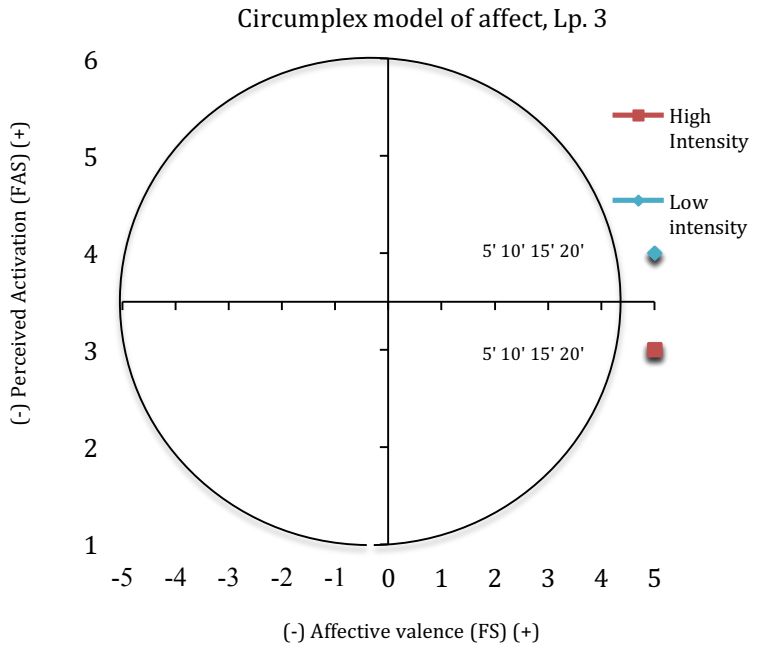
affect in the low intensity exercise trial ($F(8, 39) = 3.14$, $p < .05$) and in the high intensity exercise trial ($F(8, 39) = 3.89$, $p < .05$). Further pairwise analyses revealed significant differences between the 8 and 24 hour post exercise measurement points in the low intensity condition ($t(39) = 3.22$, $p < .01$) and high intensity condition ($t(39) = 2.02$, $p < .05$). Overall, the low intensity condition was evaluated more positively than the high intensity condition. There was no significant interaction between individuals who perceived their exercise behaviour as low or high as measured with leisure time exercise questionnaire.

Idiographic analysis - Circumplex model

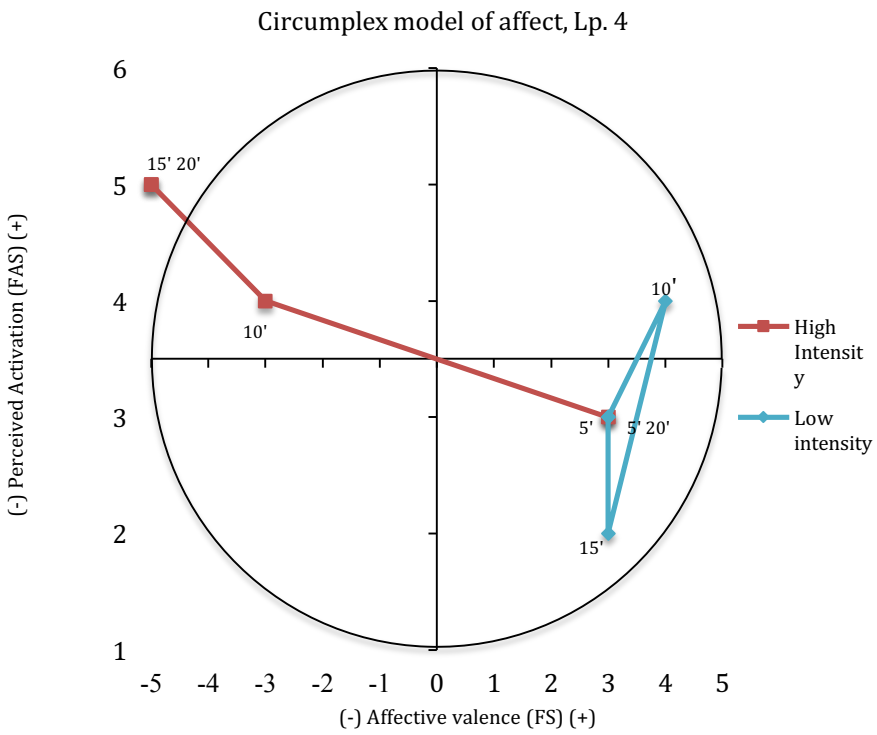
Individuals' affective responses were plotted on a Circumplex space comprised of affective valence (FS) and perceived activation (FAS) for both exercise conditions (i.e., low and high intensity). The idiographic analysis was accompanied by individuals' global affective evaluation. Please see the Circumplex space graphs in Figure 1.12.



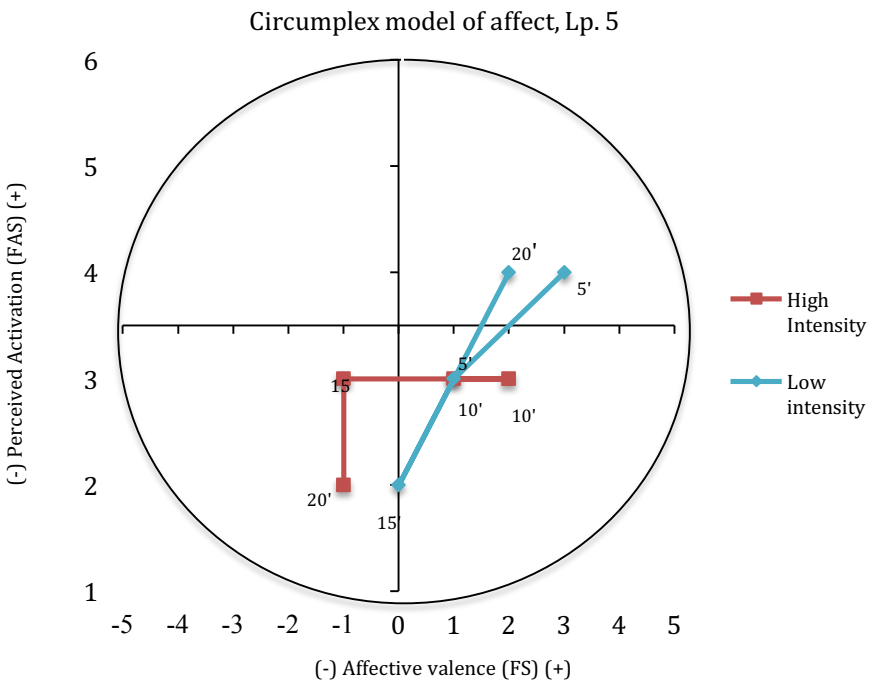
Low intensity: GAE 1' = 2, GAE 5' = 4, GAE 15' = 4, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 4, GAE 48hrs = 4, GAE 1wk = 3, GAE 2wks = 7.
High intensity: GAE 1' = 9, GAE 5' = -3, GAE 15' = 2, GAE 4hrs = 1, GAE 8hrs = -2, GAE 24hrs = -2, GAE 48hrs = 4.27, GAE 1wk = 3.64, GAE 2wks = 3.



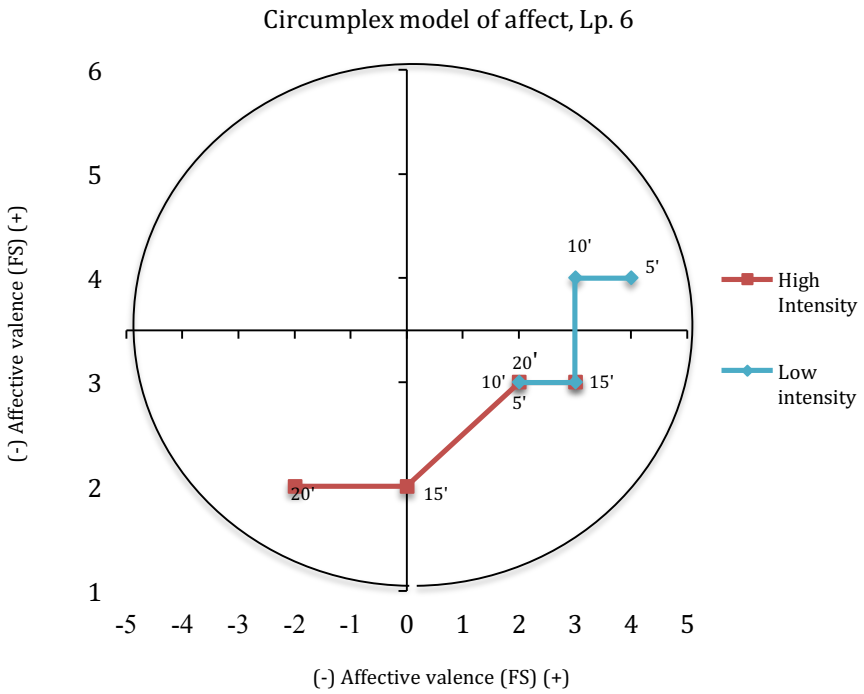
High intensity: GAE 1' = 9, GAE 5' = 9, GAE 15' = 9, GAE 4hrs = 8, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 10, GAE 1wk = 9, GAE 2wks = 9.
Low intensity: GAE 1' = 10, GAE 5' = 10, GAE 15' = 10, GAE 4hrs = 10, GAE 8hrs = 10, GAE 24hrs = 10, GAE 48hrs = 10, GAE 1wk = 10, GAE 2wks = 10.



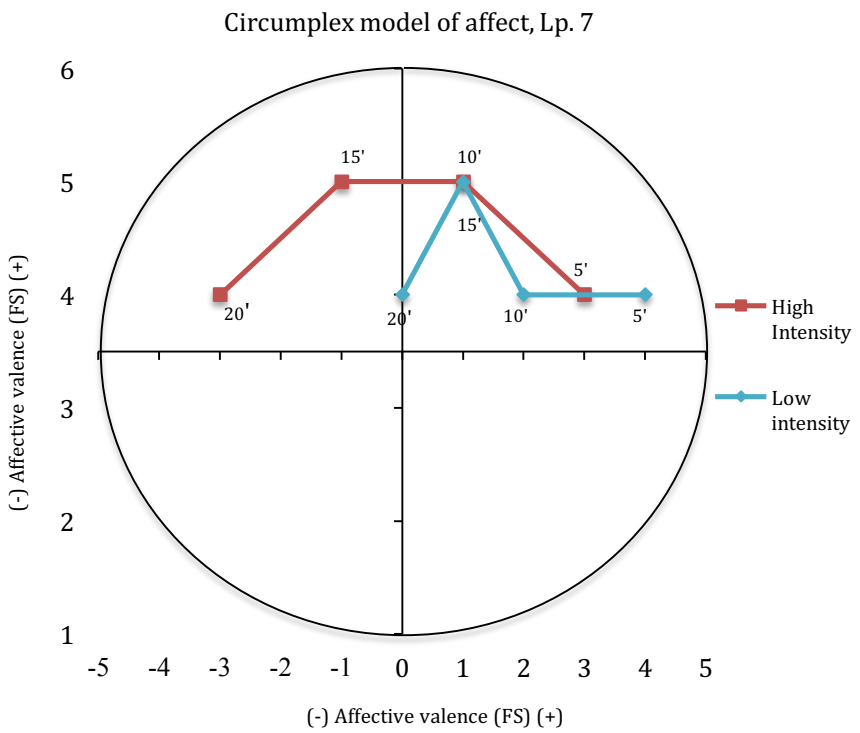
High intensity: GAE 1' = -7, GAE 5' = -5, GAE 15' = -2, GAE 4hrs = -7, GAE 8hrs = -8, GAE 24hrs = -9, GAE 48hrs = -9, GAE 1wk = -2, GAE 2wks = 0.
Low intensity: GAE 1' = 10, GAE 5' = 10, GAE 15' = 10, GAE 4hrs = 10, GAE 8hrs = 10, GAE 24hrs = 10, GAE 48hrs = 10, GAE 1wk = 10, GAE 2wks = 10.



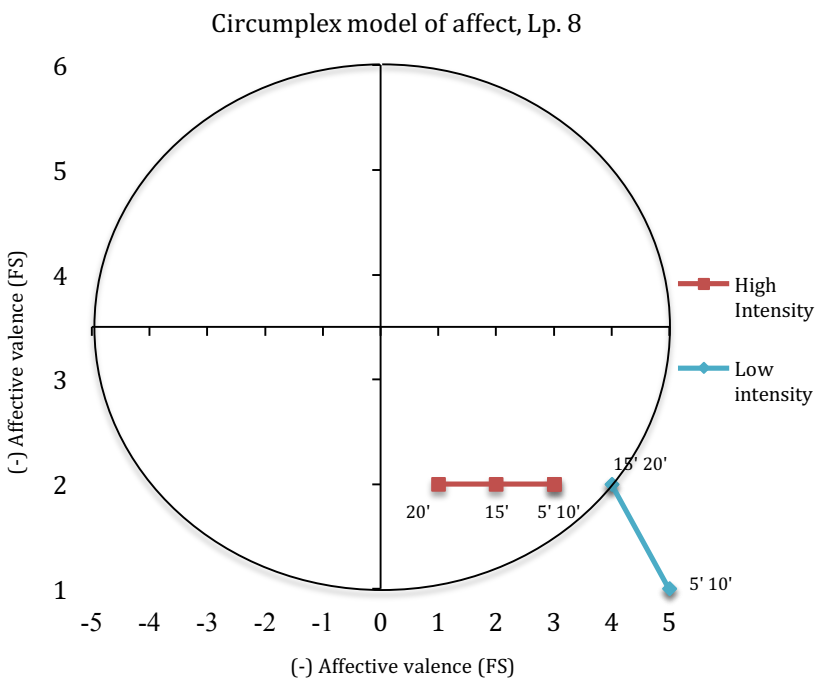
Low intensity: GAE 1' = 7, GAE 5' = 3, GAE 15' = 10, GAE 4hrs = 9, GAE 8hrs = 10, GAE 24hrs = 9, GAE 48hrs = 9, GAE 1wk = 10, GAE 2wks = 3.64.
High intensity: GAE 1' = 5, GAE 5' = 9, GAE 15' = 9, GAE 4hrs = 9, GAE 8hrs = 5.88, GAE 24hrs = 5.06, GAE 48hrs = 10, GAE 1wk = 10, GAE 2wks = 9.



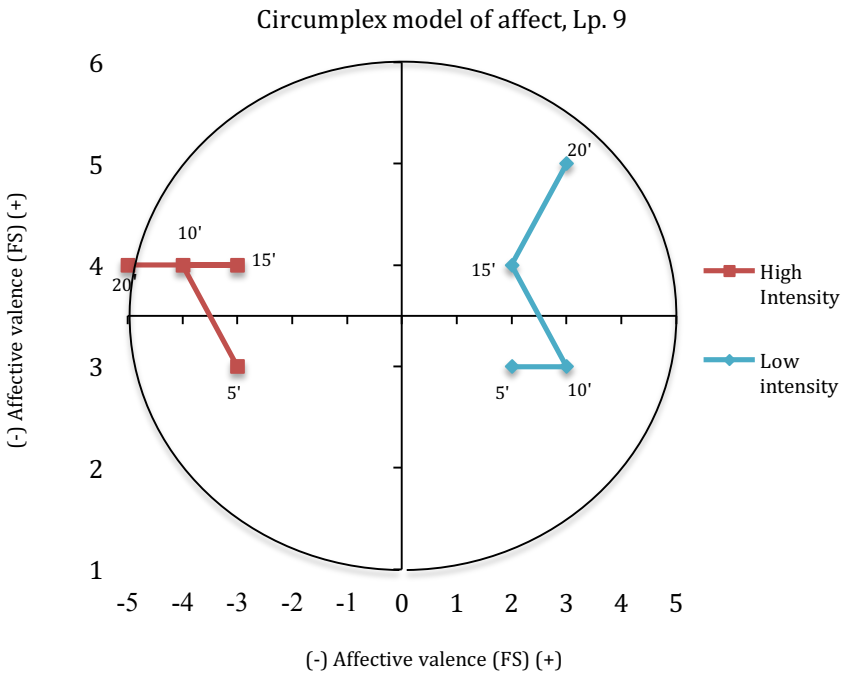
High intensity: GAE 1' = 6, GAE 5' = 7, GAE 15' = 6, GAE 4hrs = 6, GAE 8hrs = 7, GAE 24hrs = 5, GAE 48hrs = 3, GAE 1wk = 4, GAE 2wks = 8.
Low intensity: GAE 1' = 2, GAE 5' = 4, GAE 15' = 4, GAE 4hrs = 5, GAE 8hrs = 5, GAE 24hrs = -3, GAE 48hrs = 5, GAE 1wk = 5, GAE 2wks = 5.25.



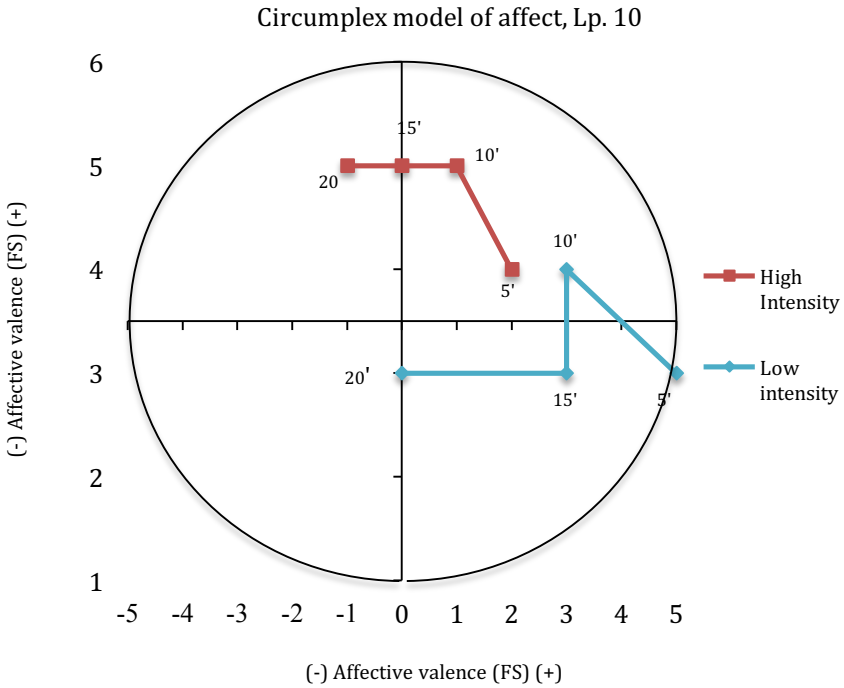
High intensity: GAE 1' = 1, GAE 5' = 1, GAE 15' = -1, GAE 4hrs = -3, GAE 8hrs = -7, GAE 24hrs = -6, GAE 48hrs = -3, GAE 1wk = 0, GAE 2wks = 1.
Low intensity: GAE 1' = 9, GAE 5' = 9, GAE 15' = 4, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 7, GAE 48hrs = 8, GAE 1wk = 8, GAE 2wks = 8.



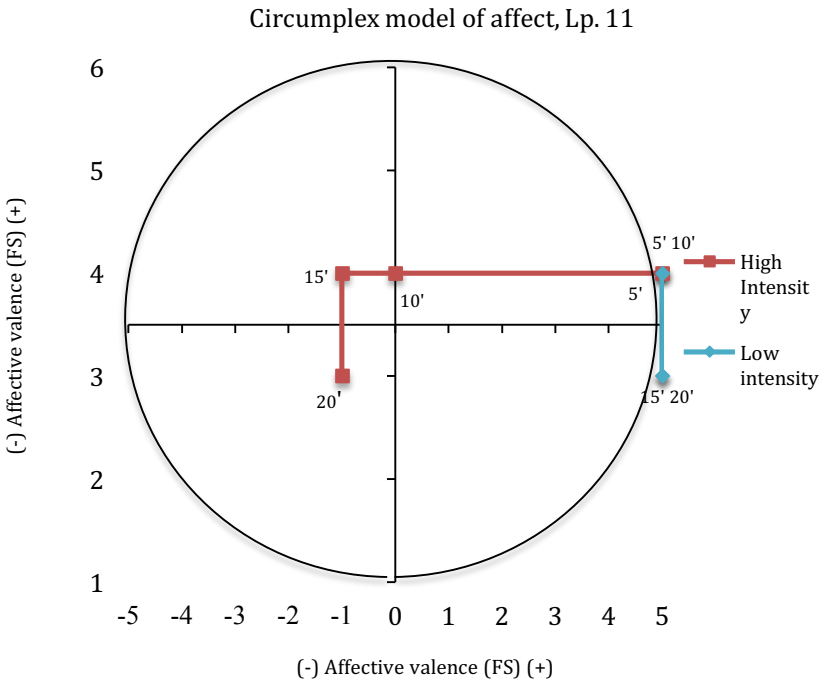
Low intensity: GAE 1' = 10, GAE 5' = 10, GAE 15' = 10, GAE 4hrs = 10, GAE 8hrs = 10, GAE 24hrs = 10, GAE 48hrs = 10, GAE 1wk = 10, GAE 2wks = 10.
High intensity: GAE 1' = 7, GAE 5' = 10, GAE 15' = 9, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 9, GAE 1wk = 10, GAE 2wks = 10.



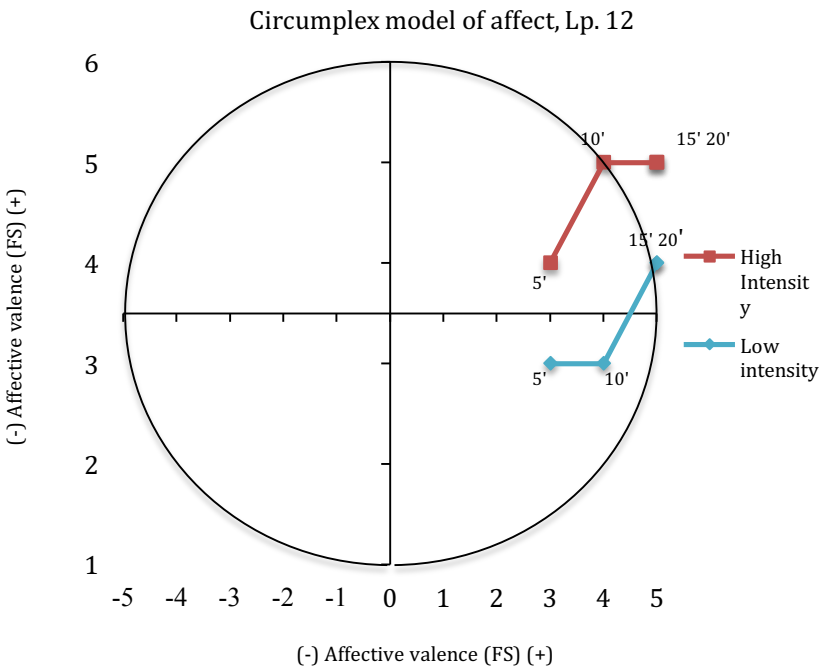
High intensity: GAE 1' = -8, GAE 5' = -8, GAE 15' = -8, GAE 4hrs = -6, GAE 8hrs = -7, GAE 24hrs = -6, GAE 48hrs = -7, GAE 1wk = -7, GAE 2wks = -7.
Low intensity: GAE 1' = 7, GAE 5' = 7, GAE 15' = 8, GAE 4hrs = 6, GAE 8hrs = 6, GAE 24hrs = 8, GAE 48hrs = 9, GAE 1wk = 8, GAE 2wks = 8.



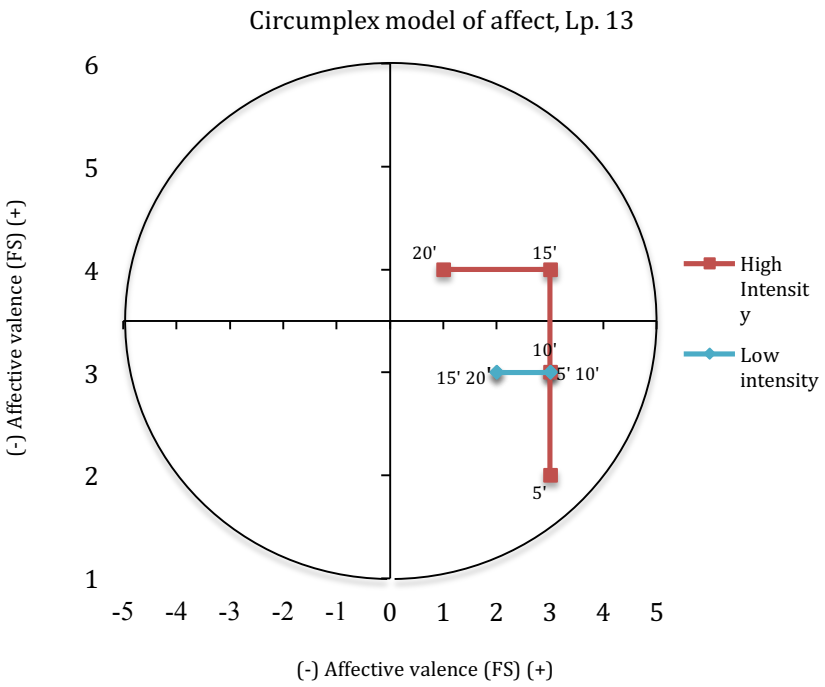
Low intensity: GAE 1' = 8, GAE 5' = 9, GAE 15' = 8, GAE 4hrs = 8.81, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 8, GAE 1wk = 8, GAE 2wks = 8.
High intensity: GAE 1' = 7, GAE 5' = 9, GAE 15' = 9, GAE 4hrs = 5.18, GAE 8hrs = 3.26, GAE 24hrs = 4, GAE 48hrs = 4, GAE 1wk = 6.23, GAE 2wks = 3.95.



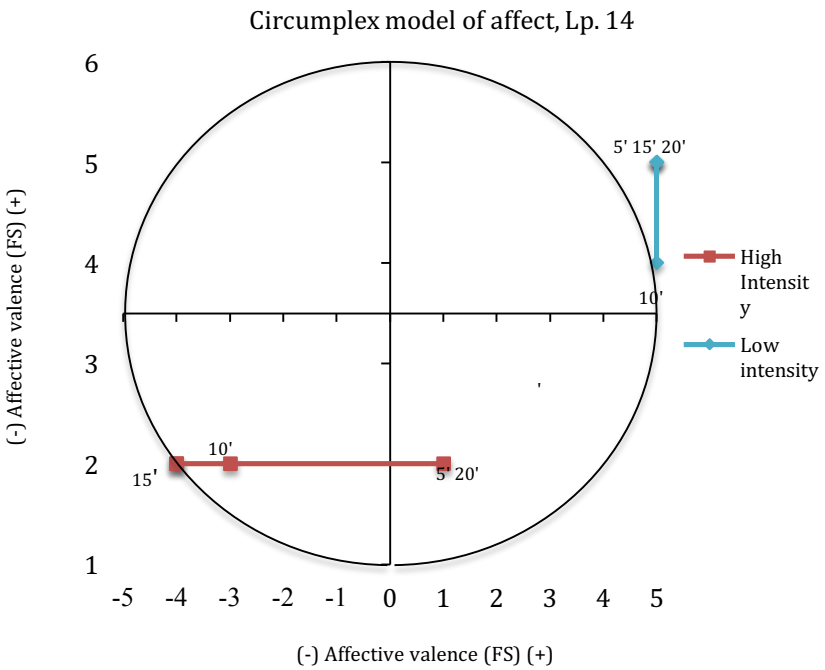
High intensity: GAE 1' = 5, GAE 5' = 5, GAE 15' = -5, GAE 4hrs = -5, GAE 8hrs = -5, GAE 24hrs = -5, GAE 48hrs = -5, GAE 1wk = -5, GAE 2wks = -5.
Low intensity: GAE 1' = 7, GAE 5' = 7, GAE 15' = 7, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 5, GAE 48hrs = 6, GAE 1wk = 6, GAE 2wks = 6.



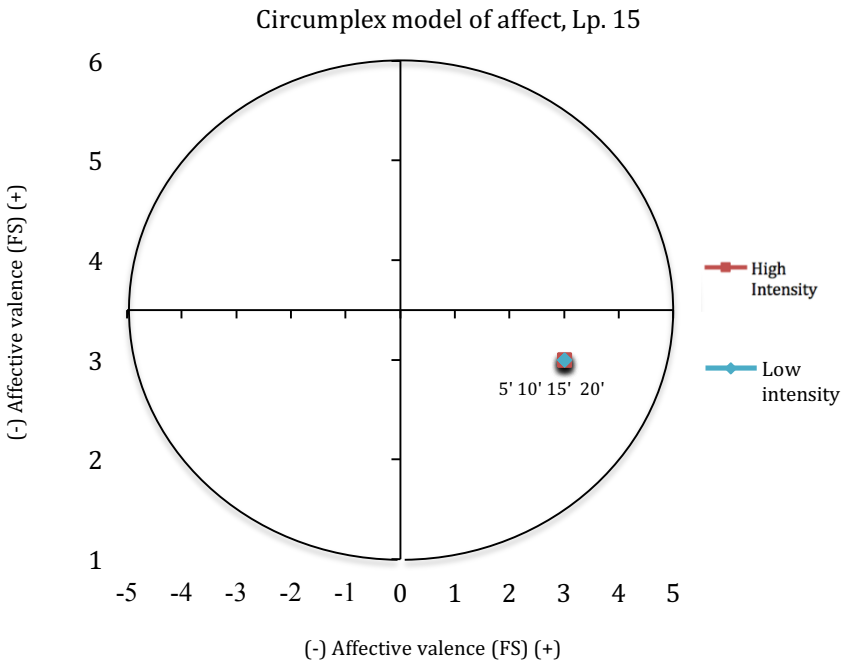
Low intensity: GAE 1' = 7, GAE 5' = 7, GAE 15' = 9, GAE 4hrs = 7, GAE 8hrs = 6, GAE 24hrs = 7, GAE 48hrs = 7, GAE 1wk = 7, GAE 2wks = 7.
High intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 9, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 8, GAE 48hrs = 8, GAE 1wk = 8, GAE 2wks = 8.



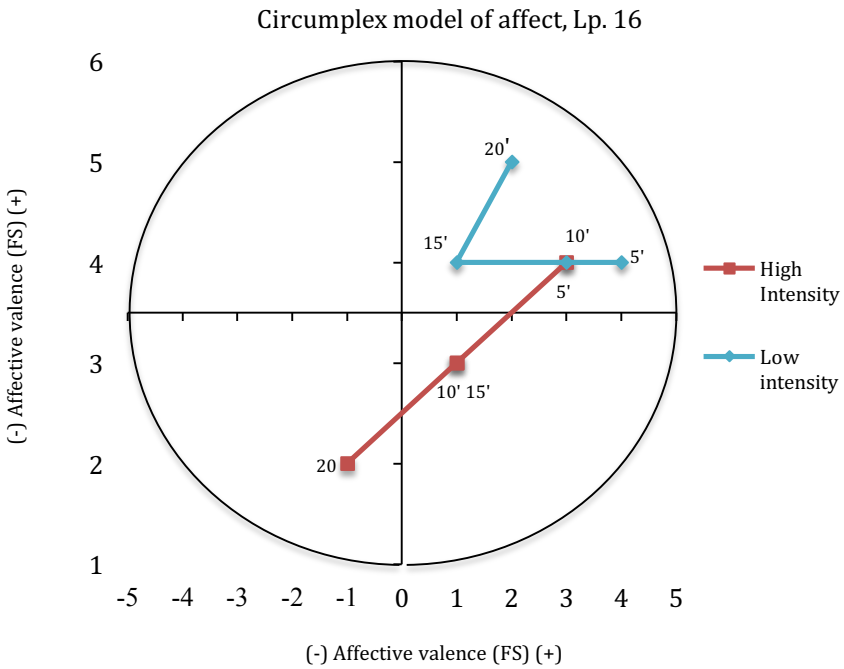
High intensity: GAE 1' = 2, GAE 5' = 1, GAE 15' = -3, GAE 4hrs = -1, GAE 8hrs = -3, GAE 24hrs = 0, GAE 48hrs = 0, GAE 1wk = 0, GAE 2wks = -1.
Low intensity: GAE 1' = 7, GAE 5' = 6, GAE 15' = 7, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 6, GAE 48hrs = 6, GAE 1wk = 7, GAE 2wks = 7.



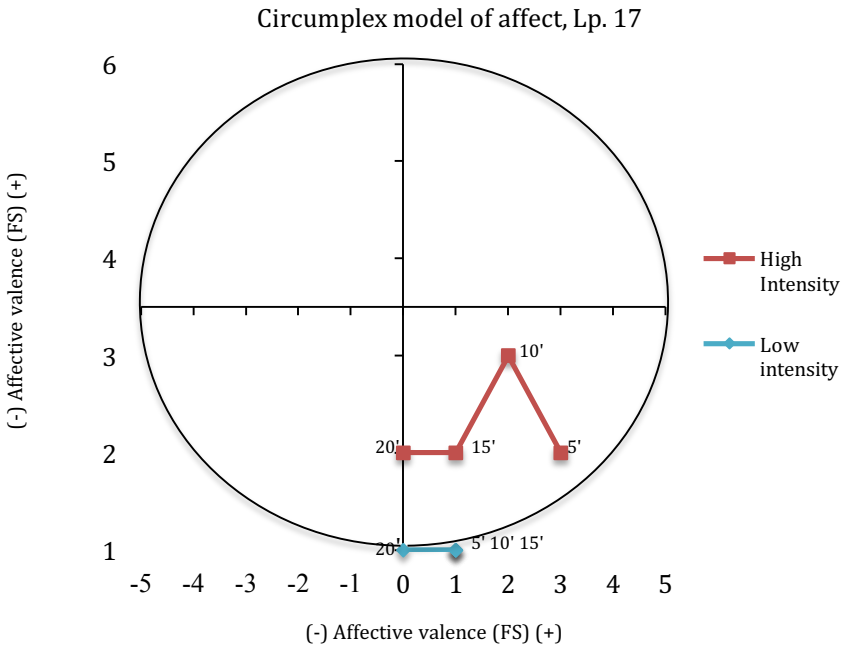
High intensity: GAE 1' = 5, GAE 5' = 6, GAE 15' = 6, GAE 4hrs = 6, GAE 8hrs = 9, GAE 24hrs = 7, GAE 48hrs = 7, GAE 1wk = 0, GAE 2wks = 3.
Low intensity: GAE 1' = 9, GAE 5' = 10, GAE 15' = 10, GAE 4hrs = 10, GAE 8hrs = 10, GAE 24hrs = 9, GAE 48hrs = 10, GAE 1wk = 10, GAE 2wks = 6.69.



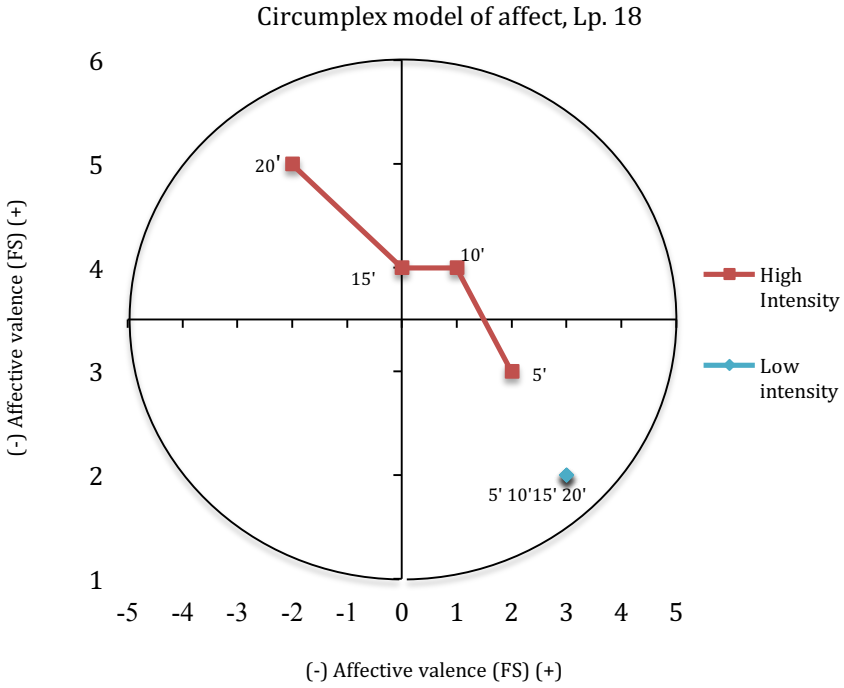
Low intensity: GAE 1' = 4, GAE 5' = 4, GAE 15' = 5, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 2, GAE 48hrs = 3, GAE 1wk = 3, GAE 2wks = 3.
High intensity: GAE 1' = 4, GAE 5' = 4, GAE 15' = 5, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 2, GAE 48hrs = 3, GAE 1wk = 3, GAE 2wks = 3.



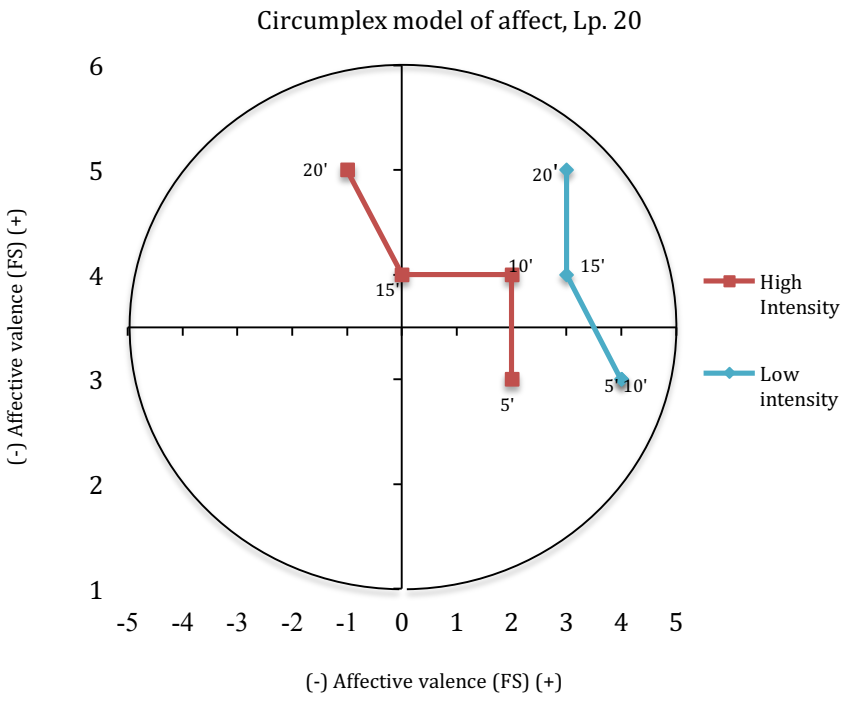
Low intensity: GAE 1' = 3, GAE 5' = 3, GAE 15' = 3, GAE 4hrs = 2, GAE 8hrs = 2, GAE 24hrs = 3, GAE 48hrs = 2, GAE 1wk = 3, GAE 2wks = 0.
High intensity: GAE 1' = -1, GAE 5' = 0, GAE 15' = -2, GAE 4hrs = -4, GAE 8hrs = -6, GAE 24hrs = -3, GAE 48hrs = -3, GAE 1wk = 0, GAE 2wks = -4.



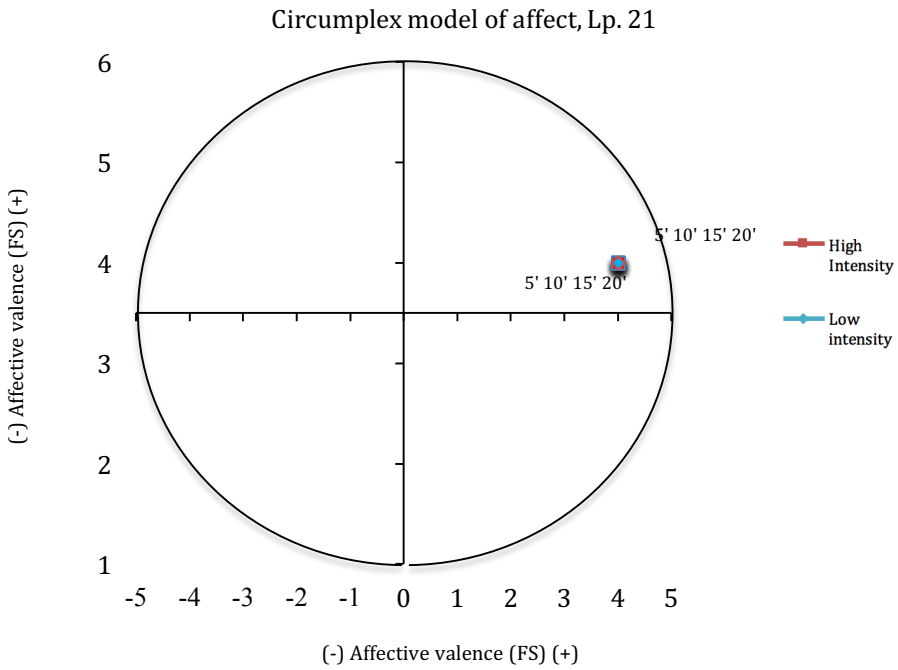
Low intensity: GAE 1' = 1, GAE 5' = 1, GAE 15' = 3, GAE 4hrs = 1, GAE 8hrs = 1, GAE 24hrs = 1, GAE 48hrs = 1, GAE 1wk = 1, GAE 2wks = 1.
High intensity: GAE 1' = 0, GAE 5' = 0, GAE 15' = 0, GAE 4hrs = 1, GAE 8hrs = 0, GAE 24hrs = 0, GAE 48hrs = 0, GAE 1wk = 0, GAE 2wks = 0.



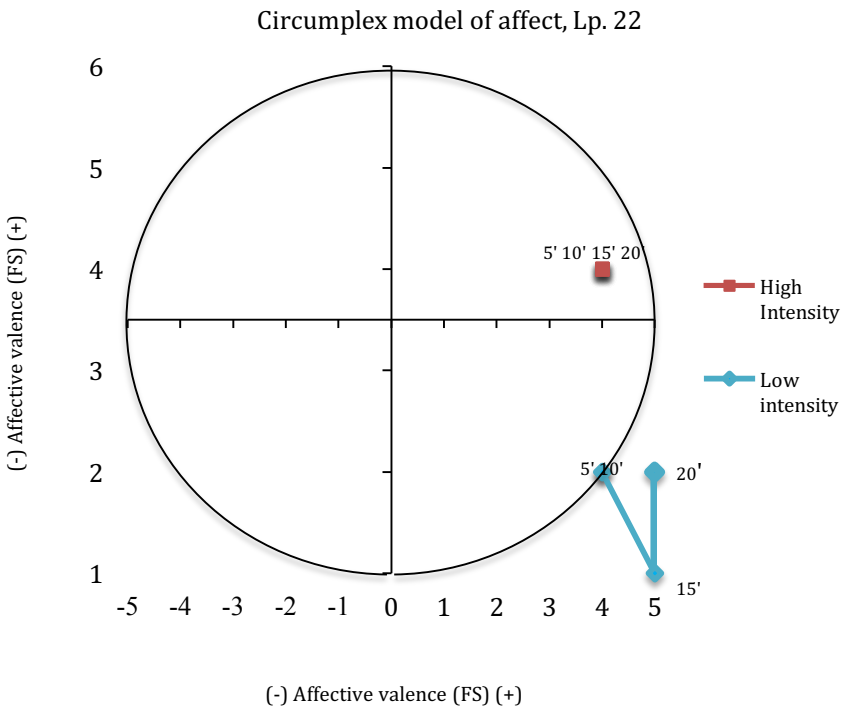
Low intensity: GAE 1' = 7, GAE 5' = 7, GAE 15' = 7, GAE 4hrs = 4, GAE 8hrs = 3, GAE 24hrs = 3, GAE 48hrs = -5, GAE 1wk = 6, GAE 2wks = 3.
High intensity: GAE 1' = -1, GAE 5' = 0, GAE 15' = -1, GAE 4hrs = -4, GAE 8hrs = -3, GAE 24hrs = -4, GAE 48hrs = -4, GAE 1wk = -4, GAE 2wks = -2.



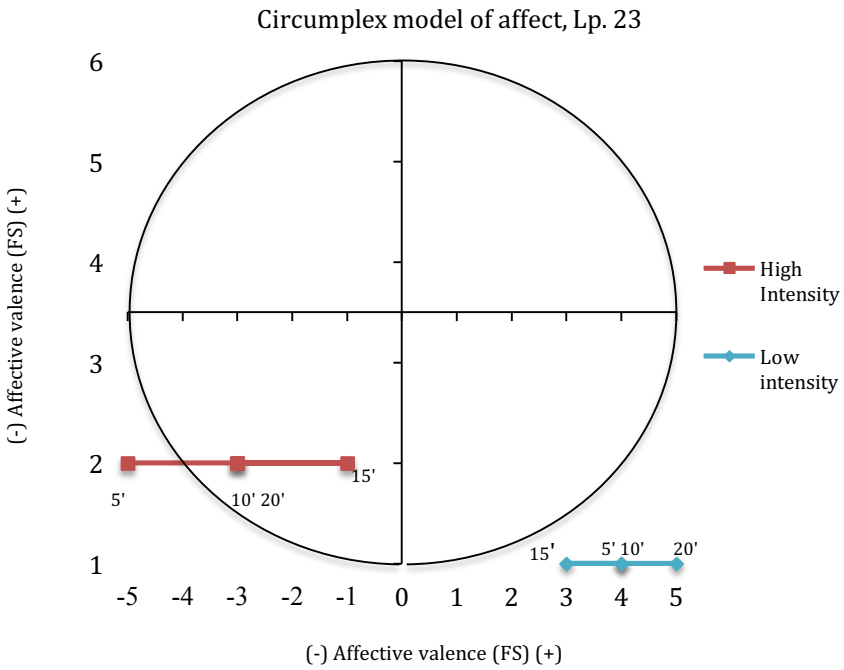
Low intensity: GAE 1' = 7, GAE 5' = 7, GAE 15' = 8, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 6, GAE 48hrs = 8, GAE 1wk = 8, GAE 2wks = 6.
High intensity: GAE 1' = -2, GAE 5' = -1, GAE 15' = -2, GAE 4hrs = 2, GAE 8hrs = 2, GAE 24hrs = -2, GAE 48hrs = -.29, GAE 1wk = 0, GAE 2wks = -.54.



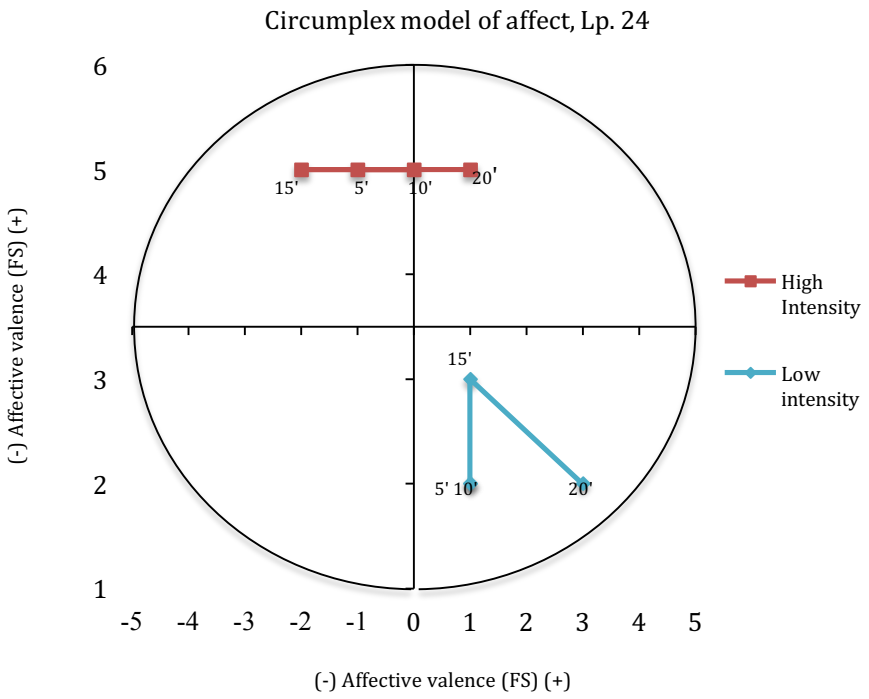
Low intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 7, GAE 4hrs = 7, GAE 8hrs = 8, GAE 24hrs = 8, GAE 48hrs = 8, GAE 1wk = 8, GAE 2wks = 8.
High intensity: GAE 1' = 6, GAE 5' = 7, GAE 15' = 8, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 8, GAE 48hrs = 8, GAE 1wk = 7.02, GAE 2wks = 8.



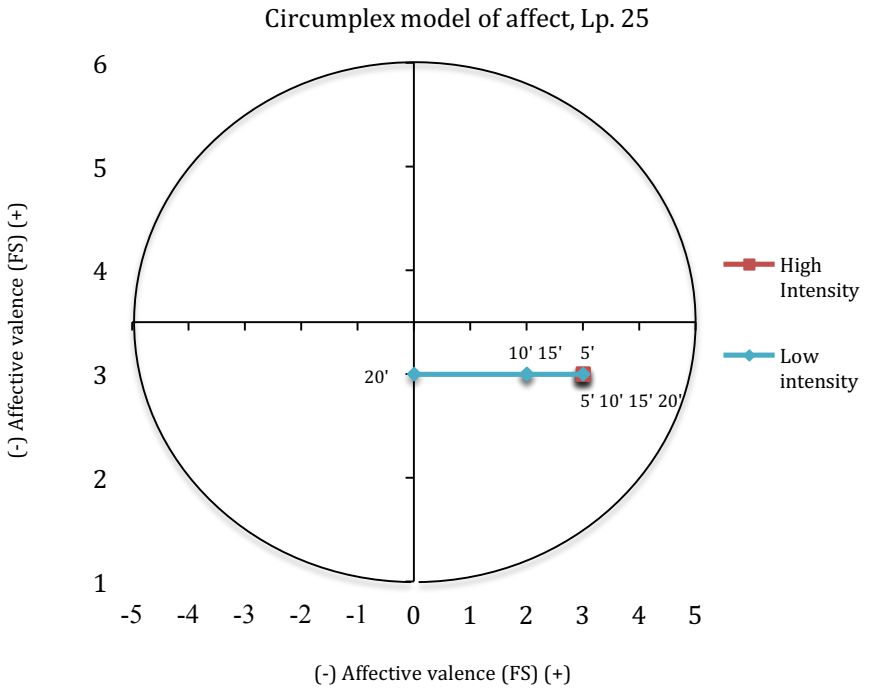
Low intensity: GAE 1' = 7, GAE 5' = 6, GAE 15' = 7, GAE 4hrs = 10, GAE 8hrs = 7, GAE 24hrs = 9, GAE 48hrs = 7, GAE 1wk = 6.8, GAE 2wks = 10.
High intensity: GAE 1' = 2, GAE 5' = 2, GAE 15' = 2, GAE 4hrs = 4, GAE 8hrs = 6, GAE 24hrs = 5, GAE 48hrs = 4, GAE 1wk = 3, GAE 2wks = 4.



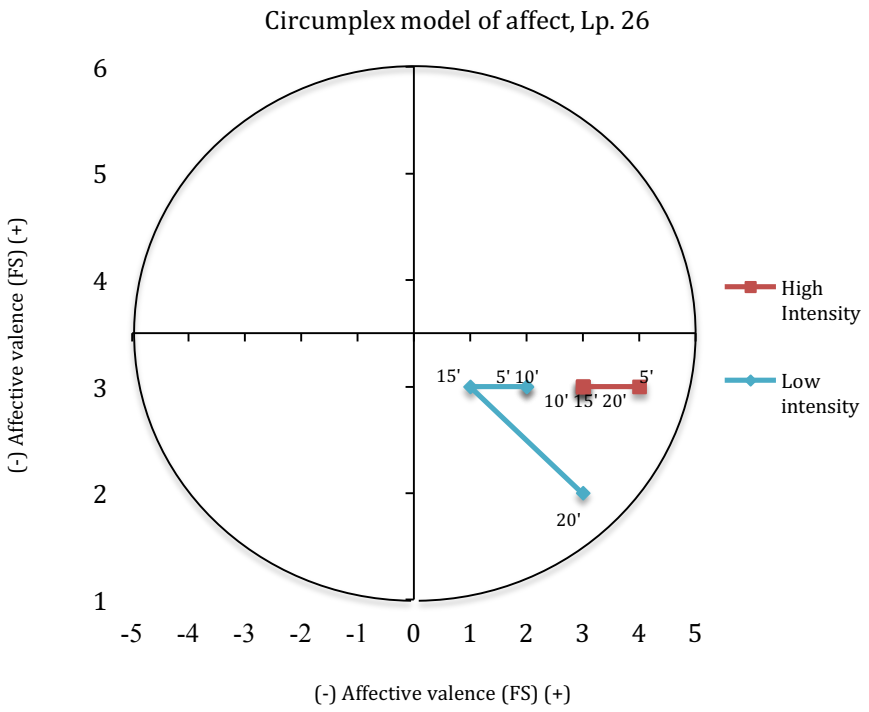
Low intensity: GAE 1' = 10, GAE 5' = 10, GAE 15' = 7, GAE 4hrs = 8, GAE 8hrs = 9, GAE 24hrs = 10, GAE 48hrs = 7.94, GAE 1wk = 10, GAE 2wks = 7.83.
High intensity: GAE 1' = 9, GAE 5' = 9, GAE 15' = 9, GAE 4hrs = 9, GAE 8hrs = 6, GAE 24hrs = 0, GAE 48hrs = 2, GAE 1wk = 3.02, GAE 2wks = 10.



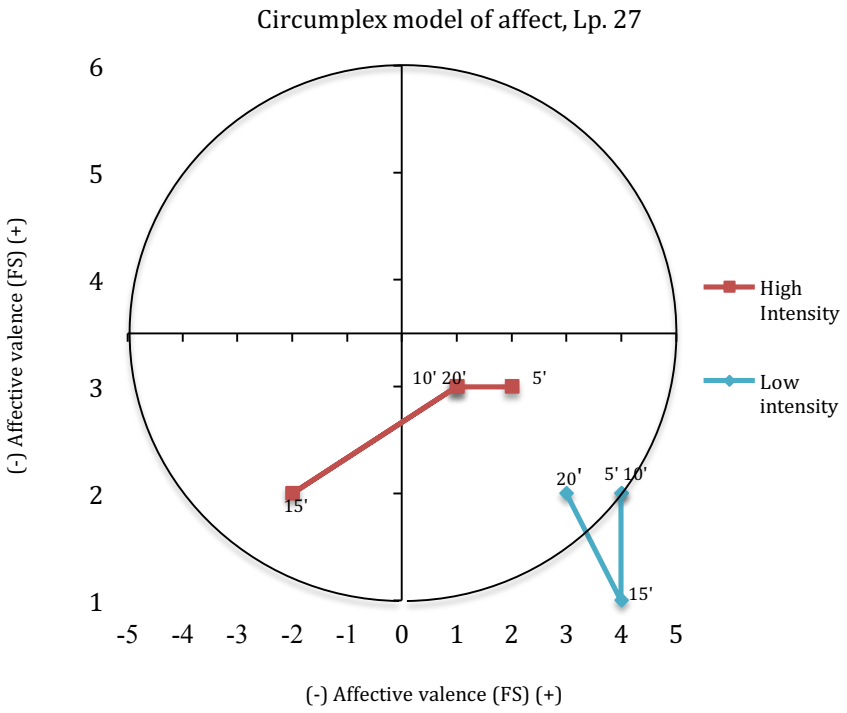
Low intensity: GAE 1' = 7, GAE 5' = 6, GAE 15' = 7, GAE 4hrs = 10, GAE 8hrs = 7, GAE 24hrs = 9, GAE 48hrs = 7, GAE 1wk = 6.8, GAE 2wks = 10.
High intensity: GAE 1' = 2, GAE 5' = 2, GAE 15' = 2, GAE 4hrs = 4, GAE 8hrs = 6, GAE 24hrs = 5, GAE 48hrs = 4, GAE 1wk = 3, GAE 2wks = 4.



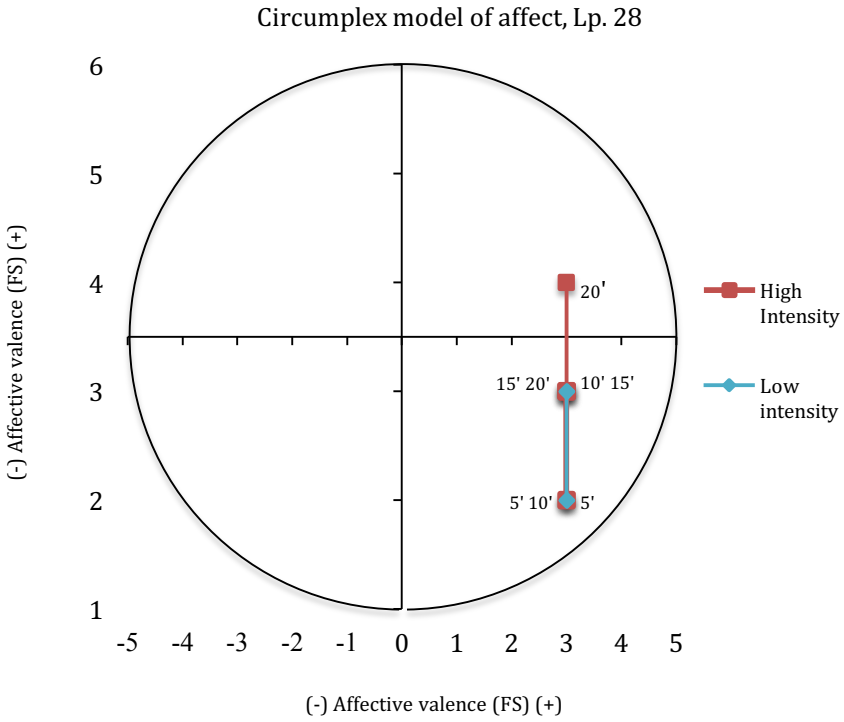
Low intensity: GAE 1' = 0, GAE 5' = 1, GAE 15' = 7, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 6, GAE 48hrs = 6, GAE 1wk = 6, GAE 2wks = 6.
High intensity: GAE 1' = 6, GAE 5' = 6, GAE 15' = 6, GAE 4hrs = 6, GAE 8hrs = 6, GAE 24hrs = 5, GAE 48hrs = 5, GAE 1wk = 6, GAE 2wks = 4.69.



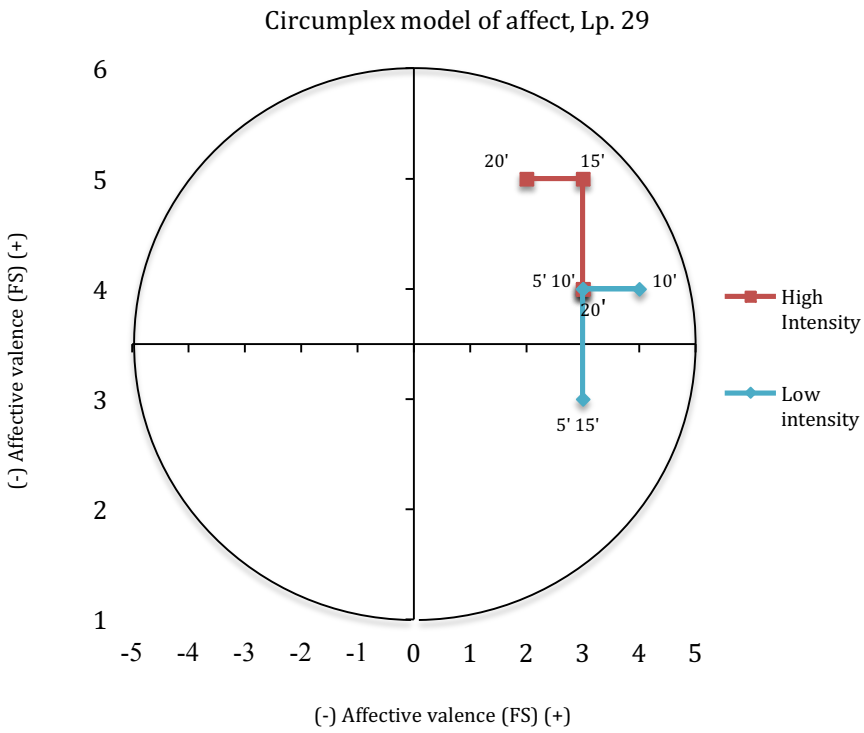
High intensity: GAE 1' = 7, GAE 5' = 5, GAE 15' =0, GAE 4hrs = 0, GAE 8hrs = 0, GAE 24hrs = 2, GAE 48hrs = 0, GAE 1wk = 0, GAE 2wks = 3.71.
Low intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 8, GAE 4hrs = 2, GAE 8hrs = 6, GAE 24hrs = 6, GAE 48hrs = 7, GAE 1wk = 7, GAE 2wks = 7.



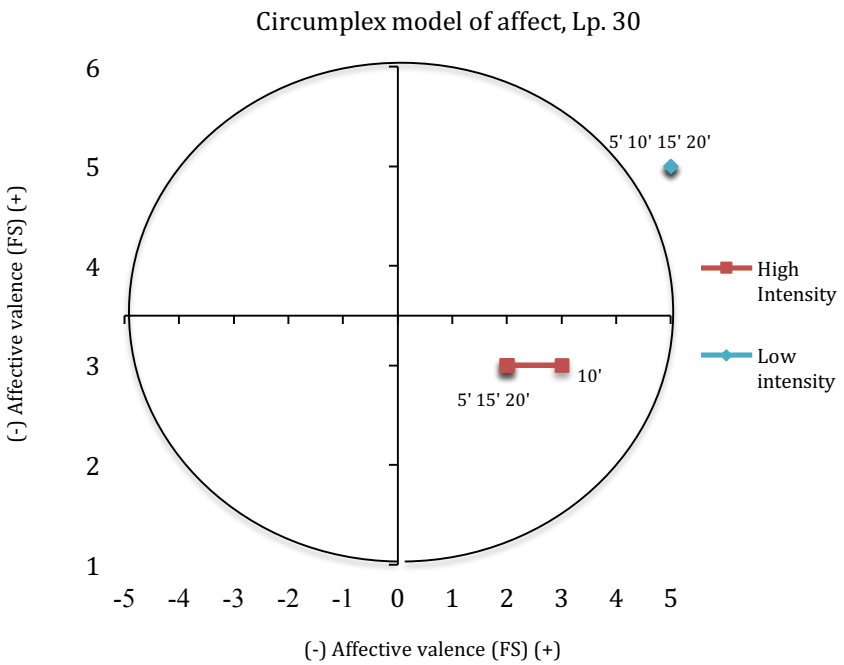
High intensity: GAE 1' = 5, GAE 5' = 6, GAE 15' = 6, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 5, GAE 48hrs = 6, GAE 1wk = 5, GAE 2wks = 6.
Low intensity: GAE 1' = 7, GAE 5' = 7, GAE 15' = 7, GAE 4hrs = 8, GAE 8hrs = 5, GAE 24hrs = 5, GAE 48hrs = 6, GAE 1wk = 4.55, GAE 2wks = 7.



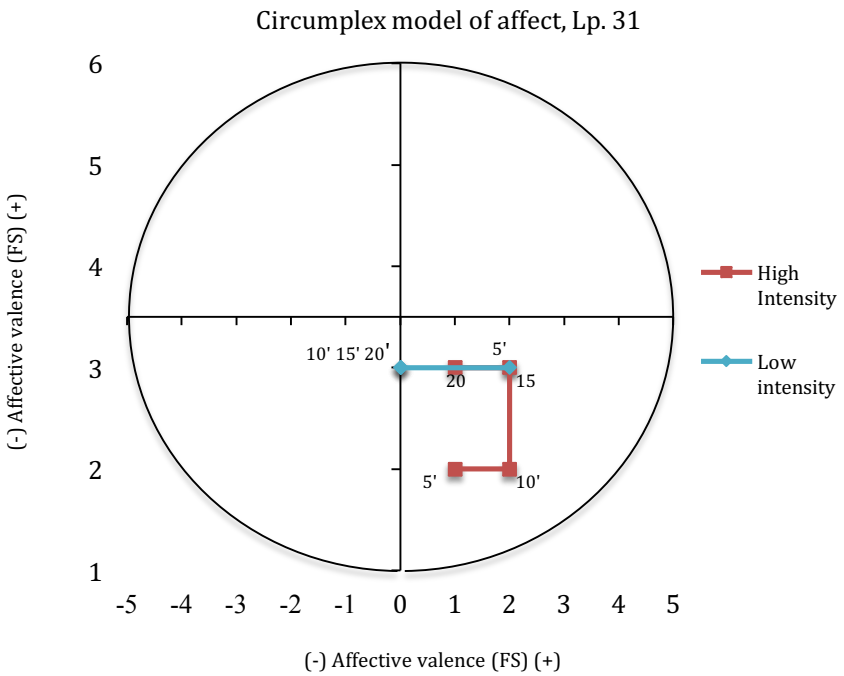
High intensity: GAE 1' = 3, GAE 5' = 5, GAE 15' = 5, GAE 4hrs = 5, GAE 8hrs = 3, GAE 24hrs = 4, GAE 48hrs = 4, GAE 1wk = 3, GAE 2wks = 3.
Low intensity: GAE 1' = 4, GAE 5' = 4, GAE 15' = 3, GAE 4hrs = 4, GAE 8hrs = 3, GAE 24hrs = 4, GAE 48hrs = 3, GAE 1wk = 4, GAE 2wks = 4.



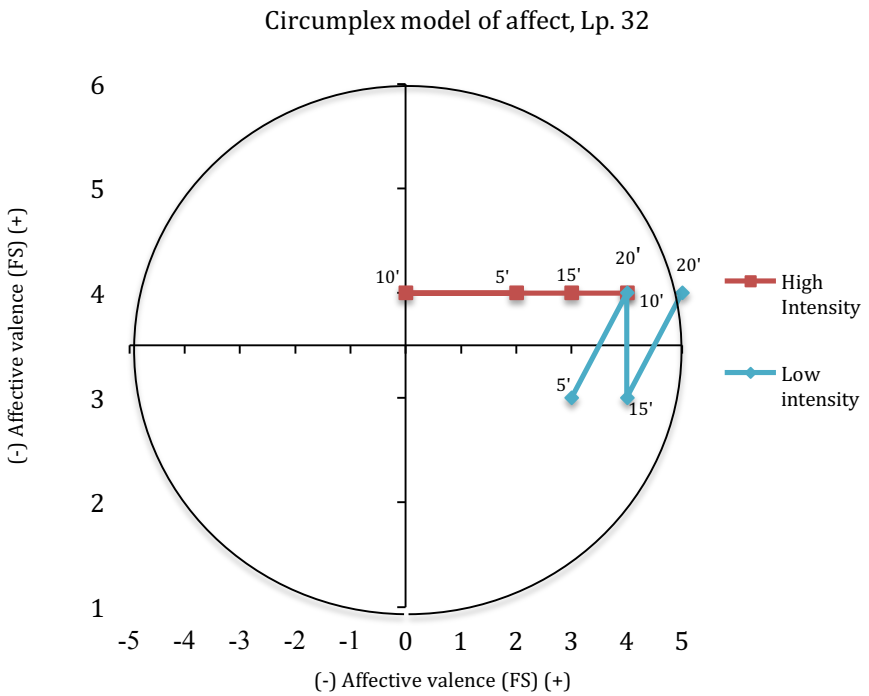
High intensity: GAE 1' = 6, GAE 5' = 6, GAE 15' = 7, GAE 4hrs = 6, GAE 8hrs = 6, GAE 24hrs = 6, GAE 48hrs = 6, GAE 1wk = 7, GAE 2wks = 7.
Low intensity: GAE 1' = 8, GAE 5' = 7, GAE 15' = 7, GAE 4hrs = 8, GAE 8hrs = 7, GAE 24hrs = 7, GAE 48hrs = 7, GAE 1wk = 8, GAE 2wks = 8.



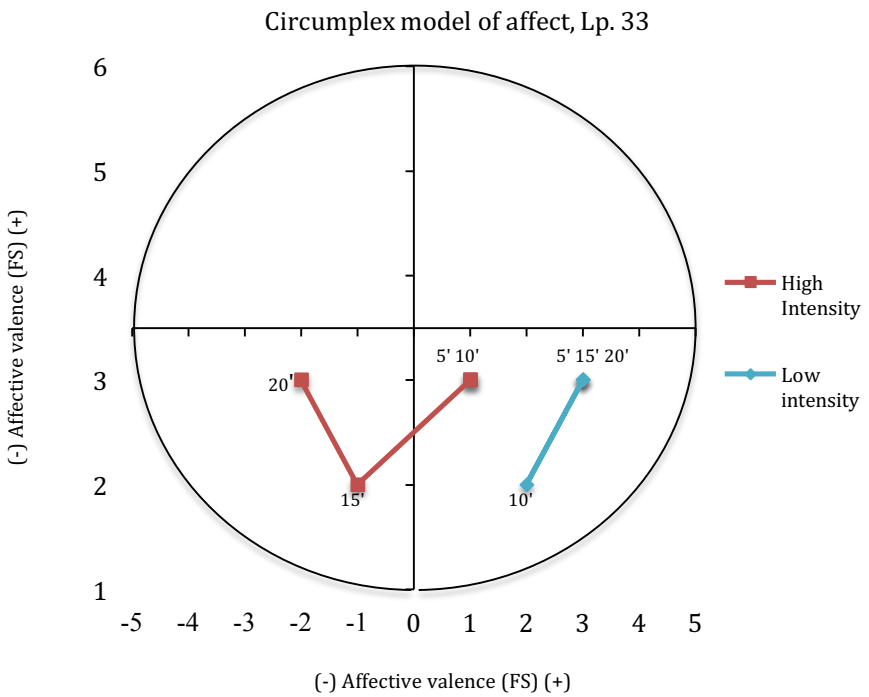
High intensity: GAE 1' = 2, GAE 5' = 4, GAE 15' = 5, GAE 4hrs = 5, GAE 8hrs = 4, GAE 24hrs = 4, GAE 48hrs = 5, GAE 1wk = 5, GAE 2wks = 6.
Low intensity: GAE 1' = 6, GAE 5' = 7, GAE 15' = 6, GAE 4hrs = 5.83, GAE 8hrs = 5, GAE 24hrs = 7, GAE 48hrs = 7, GAE 1wk = 8, GAE 2wks = 4.



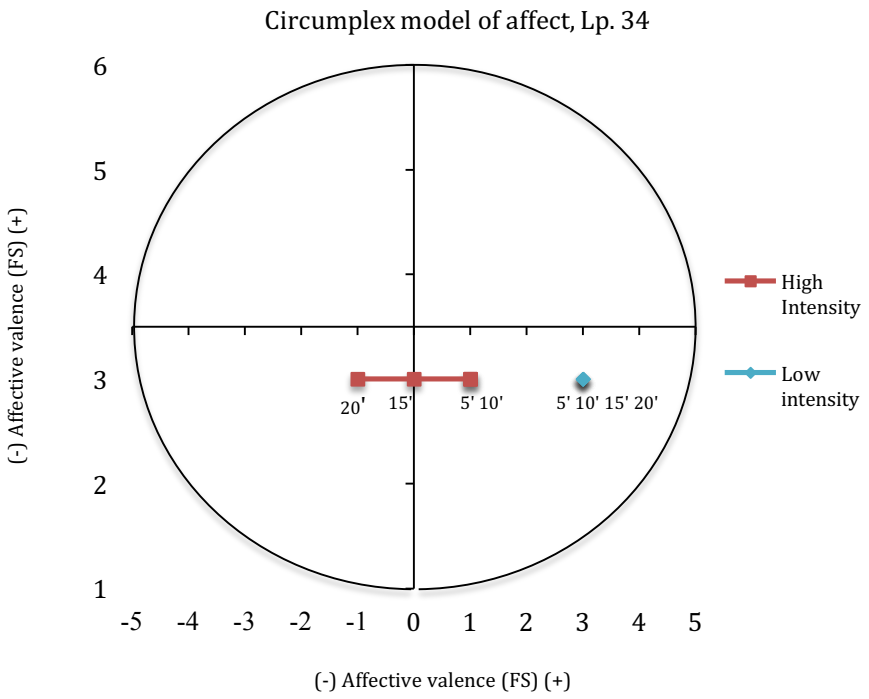
High intensity: GAE 1' = 4, GAE 5' = 6, GAE 15' = 7, GAE 4hrs = 7, GAE 8hrs = 6, GAE 24hrs = 5, GAE 48hrs = 3.76, GAE 1wk = 3, GAE 2wks = 6.
Low intensity: GAE 1' = 7, GAE 5' = 7, GAE 15' = 7, GAE 4hrs = 7, GAE 8hrs = 6, GAE 24hrs = 7, GAE 48hrs = 7, GAE 1wk = 5, GAE 2wks = 4.



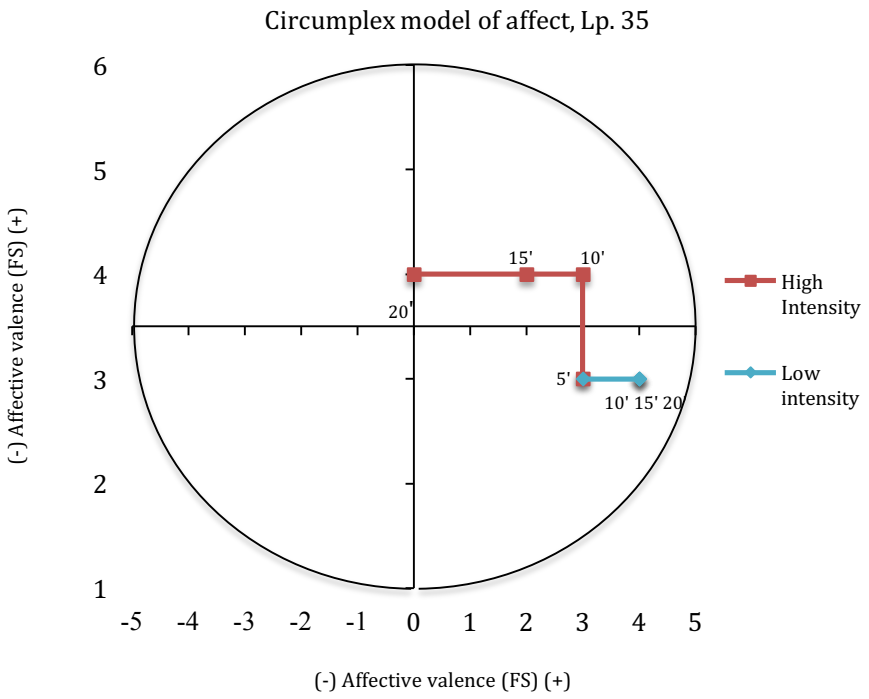
Low intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 9, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 8, GAE 48hrs = 8, GAE 1wk = 9, GAE 2wks = 10.
High intensity: GAE 1' = 10, GAE 5' = 10, GAE 15' = 10, GAE 4hrs = 10, GAE 8hrs = 10, GAE 24hrs = 9, GAE 48hrs = 9, GAE 1wk = 9, GAE 2wks = -5.



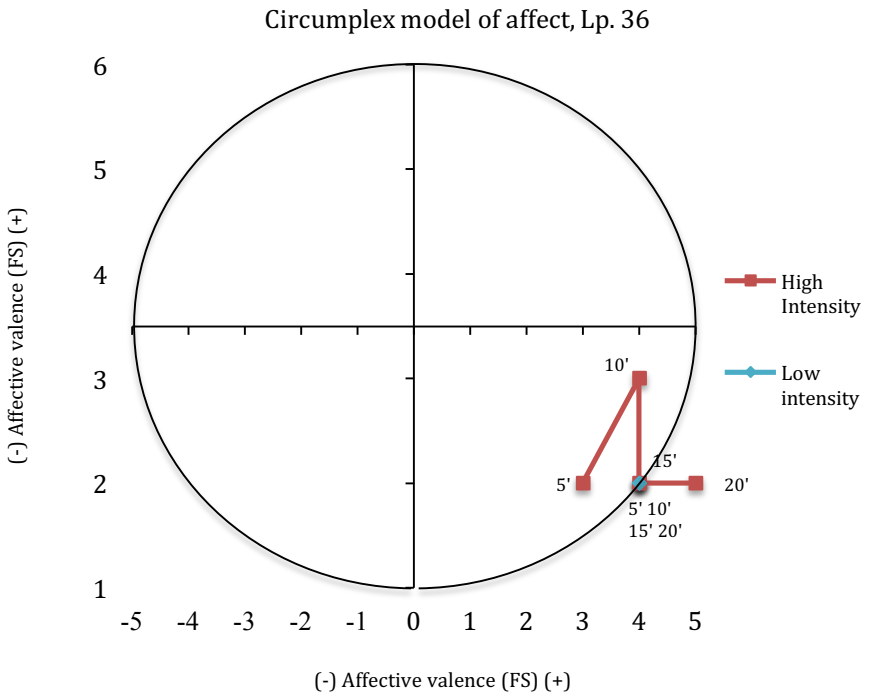
Low intensity: GAE 1' = 3, GAE 5' = 3, GAE 15' = 3, GAE 4hrs = 3, GAE 8hrs = 3, GAE 24hrs = 4, GAE 48hrs = -5, GAE 1wk = 6, GAE 2wks = 3.
High intensity: GAE 1' = -7, GAE 5' = -6, GAE 15' = -4, GAE 4hrs = -4, GAE 8hrs = -3, GAE 24hrs = -4, GAE 48hrs = -4, GAE 1wk = -2, GAE 2wks = -2.



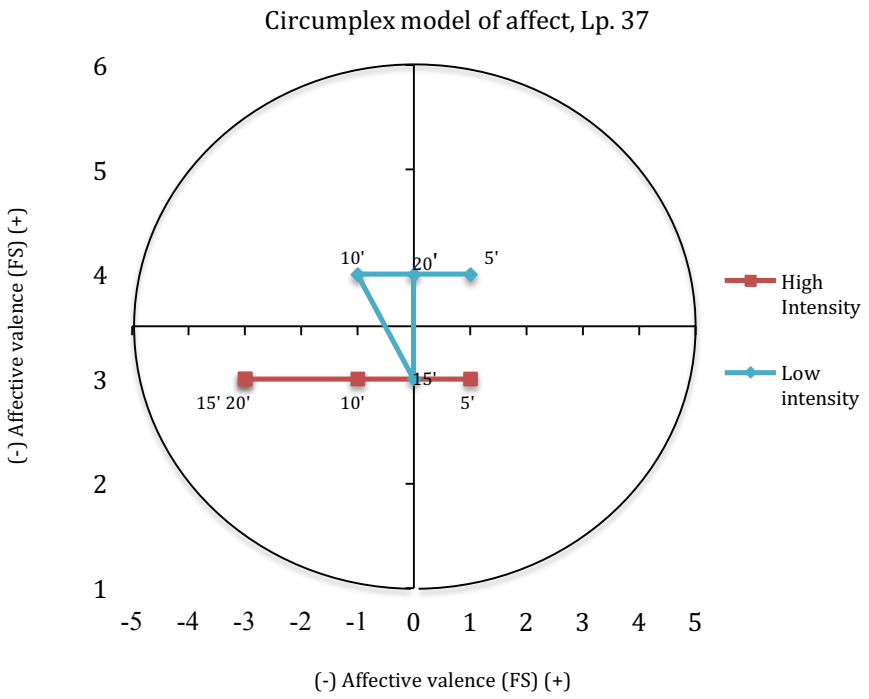
Low intensity: GAE 1' = 6, GAE 5' = 6, GAE 15' = 6, GAE 4hrs = 6, GAE 8hrs = 4, GAE 24hrs = -1, GAE 48hrs = 6, GAE 1wk = 7, GAE 2wks = 6.
High intensity: GAE 1' = 3, GAE 5' = 4, GAE 15' = 4, GAE 4hrs = 3, GAE 8hrs = 5, GAE 24hrs = 6.11, GAE 48hrs = 5, GAE 1wk = 6, GAE 2wks = 6.



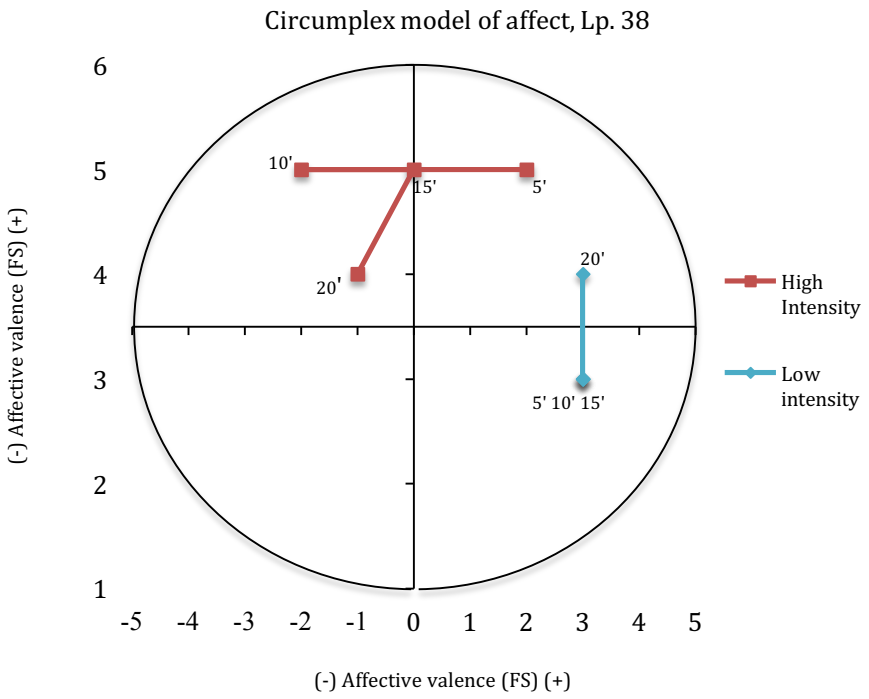
Low intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 8, GAE 4hrs = 7, GAE 8hrs = 8, GAE 24hrs = 7, GAE 48hrs = 7, GAE 1wk = 0, GAE 2wks = 0.
High intensity: GAE 1' = 3, GAE 5' = 4, GAE 15' = 1, GAE 4hrs = 1, GAE 8hrs = -3, GAE 24hrs = -1, GAE 48hrs = -2, GAE 1wk = -2, GAE 2wks = 0.



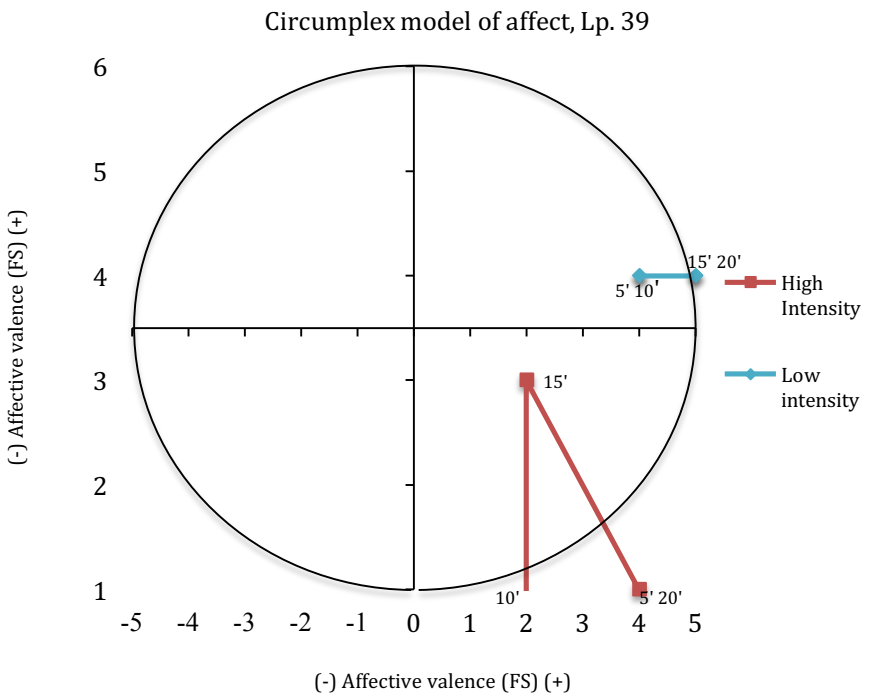
High intensity: GAE 1' = 9, GAE 5' = 9, GAE 15' = 9, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 9, GAE 1wk = 9, GAE 2wks = 9.
Low intensity: GAE 1' = 10, GAE 5' = 10, GAE 15' = 10, GAE 4hrs = 10, GAE 8hrs = 10, GAE 24hrs = 10, GAE 48hrs =10, GAE 1wk = 10, GAE 2wks = 10.



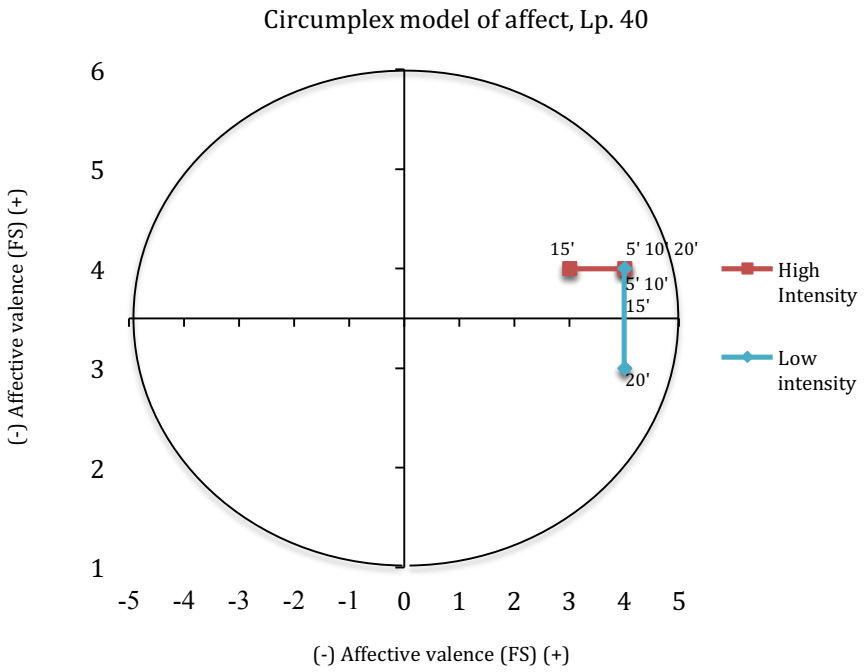
High intensity: GAE 1' = -5, GAE 5' = -3, GAE 15' = -8, GAE 4hrs = -8, GAE 8hrs = -8, GAE 24hrs = -8, GAE 48hrs = -8, GAE 1wk = -8, GAE 2wks = -8.
Low intensity: GAE 1' = 0, GAE 5' = 0, GAE 15' = -2, GAE 4hrs = -1, GAE 8hrs = -1, GAE 24hrs = -2, GAE 48hrs = -2, GAE 1wk = -2, GAE 2wks = -1.



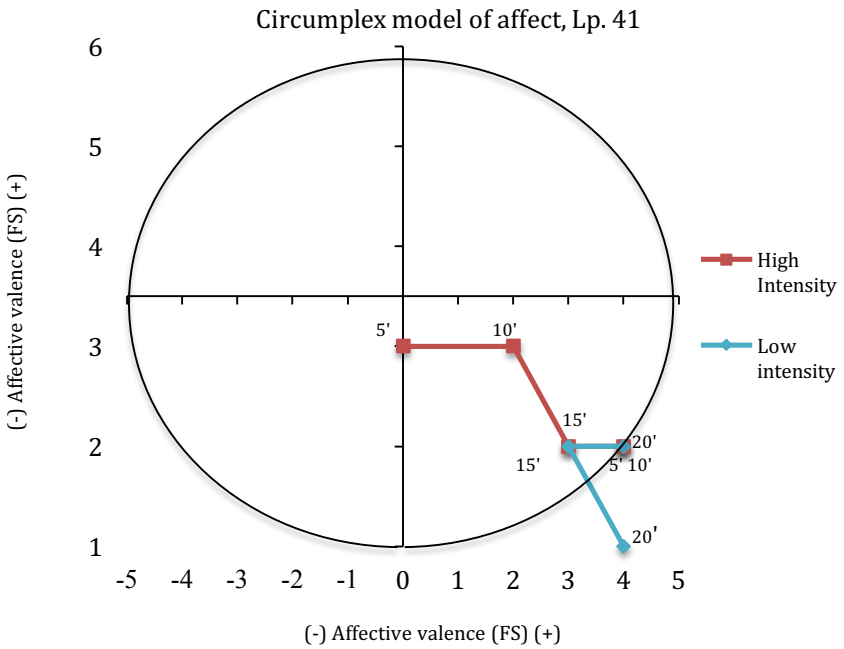
High intensity: GAE 1' = -1, GAE 5' = -1, GAE 15' = -1, GAE 4hrs = -1, GAE 8hrs = -1, GAE 24hrs = -1, GAE 48hrs = -1, GAE 1wk = -1, GAE 2wks = -1.
Low intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 8, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 8, GAE 48hrs = 8, GAE 1wk = 8, GAE 2wks = 8.



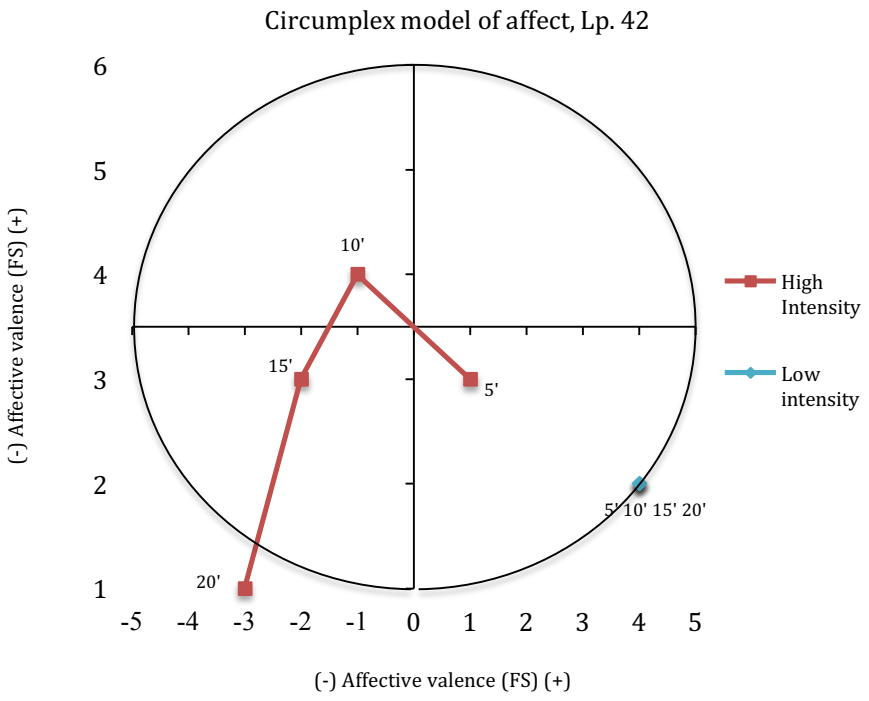
Low intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 8, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 9, GAE 1wk = 9, GAE 2wks = 9.
High intensity: GAE 1' = 9, GAE 5' = 9, GAE 15' = 9, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 6.28, GAE 48hrs = 9, GAE 1wk = 9, GAE 2wks = 9.



High intensity: GAE 1' = 4, GAE 5' = 4, GAE 15' = 4, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 4, GAE 48hrs = 4, GAE 1wk = 4, GAE 2wks = 4.
Low intensity: GAE 1' = 4, GAE 5' = 4, GAE 15' = 4, GAE 4hrs = 8.37, GAE 8hrs = 7, GAE 24hrs = 7, GAE 48hrs = 7, GAE 1wk = 7, GAE 2wks = 8.



Low intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 8, GAE 4hrs = 8, GAE 8hrs = 9, GAE 24hrs = 7, GAE 48hrs = 6, GAE 1wk = 8, GAE 2wks = 8.
High intensity: GAE 1' = 8, GAE 5' = 8, GAE 15' = 8, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 6, GAE 48hrs = 8, GAE 1wk = 5.23, GAE 2wks = 8.



Low intensity: GAE 1' = 0, GAE 5' = 0, GAE 15' = 0, GAE 4hrs = 0, GAE 8hrs = 0, GAE 24hrs = 0, GAE 48hrs = 0, GAE 1wk = 0, GAE 2wks = 0.
High intensity: GAE 1' = 2, GAE 5' = 3, GAE 15' = -6, GAE 4hrs = -4, GAE 8hrs = -4, GAE 24hrs = -4, GAE 48hrs = -4, GAE 1wk = -2, GAE 2wks = -2.

Figure 1.12. Idiographic analysis of individual' responses plotted on Circumplex space.

Anticipatory feelings

A multiple regression analysis indicated that anticipatory feelings measured before the second run explained 38% of variance in the measurement points of feelings states (FS) obtained during the exercise bout ($F(4, 36) = 4.82$, $p < .01$) and 77% of variance was explained by the recall measurement of affective valence (GAE) collected after the exercise terminated ($F(9, 23) = 5.55$, $p < .01$).

Table 1.4
Coefficients for a Regression Model with Anticipatory Feelings as a Dependent Variable.

	Beta	***t***	***p***
FS at 5 min of exercise	.00	-.03	.63
FS at 10 min of exercise	.00	1.38	.18

FS at 15 min of exercise	.049	-1.89	.07
FS at 20 min of exercise	.571	2.18	.04

Table 1.5
Coefficients for a Regression Model with Anticipatory Feelings as a Dependent Variable.

	Beta	***t***	***p***
GAE 1 min post exercise	-.31	-.35	.73
GAE 5 min post exercise	.89	.92	.37
GAE 40 min post exercise	-.59	-.03	.30
GAE 4 hr post exercise	-.85	1.38	.52
GAE 8 hr post exercise	.36	-1.89	.70
GAE 24 hrs post exercise	.39	2.18	.45
GAE 48 hrs post exercise	1.08	2.76	.01
GAE 1 week post exercise	1.48	2.51	.02
GAE 2 weeks post exercise	-1.58	-2.84	.01

Predicting recalled affective states at 24hrs post exercise

A multiple regression analysis showed that recalled affective states from low intensity exercise explained 88% of variance by the four measurement points of feelings states obtained during the exercise bout together with the five recall measurement of affective states prior to 24 hrs measurement point ($F(9, 36) = 21.89$, $p < .001$). Furthermore, a multiple regression analysis showed that recalled affective states from the high intensity exercise explained 92% of variance by the four measurement points of feelings states obtained during the exercise bout together with the five recall measurement of affective states prior to 24hrs measurement point ($F(9, 36) = 21.89$, $p < .001$).

Idiographic analyses

Methods of idiographic analyses employed in this study were derived from previous research (e.g., Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007; Ekkekakis, Hall, & Petruzzello, 2008). Based on the analysis of data comprising this study, three groups were established in accordance to whether participants moved in quadrants of affective space in circumplex model and in particular whether individuals moved on affective valence dimension (FS). Three distinct analyses were carried out; the first analysis compared individual responses across both exercise intensity conditions. For the purpose of the analysis, responses from the feeling state scale (FS) and global affective evaluation scale (GAE) were considered. Three groups were established for each of the two exercise intensity condition: a) individuals experiencing a shift from negative to pleasant affective states ("1" or higher, on "-5" to "+5" scale); b) individuals who maintained a consistent affective states; and c) individuals who shifted to negative affective space ("-1" or lower, on "-5" to "+5" scale). GAE (recall) was analysed together with feeling state responses; recall responses were clustered into two groups whether individuals' recall from exercise experience was unpleasant (registered as "-1" and lower, on "-10" to "+10" scale) or pleasant (registered as "0" and higher, on "-10" to "+10" scale), during any of the 9 recall measurement point, over the 2 weeks post exercise. Results showed that in the low intensity exercise condition, from a total of 40 participants, none of the participants experienced a shift from positive to negative affective states with one exception; a participant (Lp. 37) experienced a shift from pleasant to unpleasant affect, however the participant returned to a positive feeling state prior to the termination of exercise. The analysis showed that 12.5% (n = 5) of all participants in the low exercise intensity condition had at least one negative affect recall over the 2 weeks time period. In the high exercise condition 35% (n = 14) participants shifted from pleasant to unpleasant

affective states during exercise. The same number of individuals recalled (from the high intensity exercise) the exercise as unpleasant at least once during the 2 weeks post exercise measurement (GAE). Further, of the participants that experienced a shift from pleasant to unpleasant affective states during high intensity exercise, 71.4% recalled the exercise as unpleasant. Overall, 45% (n = 18) of all participants in the high intensity exercise either experienced a decline in affective states that ended up in an unpleasant affective space, or recalled exercise experience as unpleasant, or experienced both unpleasant experience and recalled exercise adversely. The average magnitude of change for the group that experienced a shift towards unpleasant affective states was M = 3.73 with SD = 1.66. There was only one participant included in a group that shifted from negative to pleasant affective states (Lp.24).

In the second analysis, three groups were compared across the two exercise conditions to investigate whether changes in affective states were associated with a change in recall of exercise experience. Groups were comprised of individuals who: a) stayed in positive affective states in both exercise conditions, b) individuals who remained in pleasant affective states during low exercise intensity condition and decline into unpleasant affective states during high intensity exercise, and c) individuals who shifted to unpleasant affective states during both exercise conditions. Analyses showed that individuals who stayed in pleasant affective states across both exercise conditions (responded between "5" and "0" on FS scale) accounted for 47.5% (n = 19) of total participants (n = 40) and 21% of those experienced at least one unpleasant recall during the 2 weeks post measurement time. Individuals who remained in a pleasant affective state during exercise in the low exercise intensity condition and shifted to an unpleasant affective state in the high intensity exercise condition accounted for 52.5% of total participants in the study, from which 66.7% recorded unpleasant recall at least once over

the post exercise measurement period. There were no individuals who shifted towards an unpleasant affective state during both exercise intensity conditions that remained in unpleasant affect. Notably, one participant (Lp. 37) has in fact shifted in the high intensity exercise condition to unpleasant affective states, and moved across the circumplex space during low intensity exercise reaching unpleasant affective states, however before completion of low intensity exercise has returned to neutral ("0" on FS scale). This individual was not categorised to be within a range of unpleasant affect and was not accounted for in the third group (changed to unpleasant affective states during both exercise intensity conditions).

The third analysis examined changes in affective valence between commencement and termination of the exercise associated with recall (GAE). Three groups were formed for each of the two study conditions (high and low intensity exercise); g) individuals who experienced a decline in affective states during exercise; h) individuals who did not move in affective valence during the exercise (or returned to the same point); and i) individuals who experience an improvement in affective states. The analysis showed that in the low intensity exercise condition, 42.5% (n = 17) individuals did not move from the affective space (or returned to the same point). Three individuals (Lp. 6, Lp. 33, and Lp.34) recorded an unpleasant recall from exercise during at least one point of post measurement time (GAE). A group with a decline in affective states represented 35% of total participants (n = 14) from which two participants recalled their exercise as unpleasant. The average magnitude of change among those participants was M = 1.86, SD = 1.29. The remaining group of participants who experienced an improvement in feeling states during exercise accounted for 22.5% of the total sample (n = 9) and there was no one who recalled exercise as an unpleasant experience. The magnitude of the positive change was M = 1.33, SD = 0.5. In the high exercise condition,

30% of participants (n = 12) did not record any changes in affective states (or returned to the starting point). A group with a decline in affective states represented 55% of participants (n = 22), among whom 13 participants reported unpleasant recall from exercise in post exercise measurement (GAE). The magnitude for the change in the decline group was M = 3.36, SD = 1.79. Individuals who experienced an improvement in affective states in high exercise intensity constitute 15% (n = 6) of participants, with one person (Lp. 32) recalling exercise as unpleasant at one measurement point (2 weeks post exercise). The magnitude of change among those individuals was M = 2.67, SD = 1.03.

Peak-end rule

Paired samples t-tests have been conducted to examine whether the peak and end rule could be observed in the data collected. After exploratory analysis examining the descriptive data, clear 'peaks' amongst individuals' responses did not emerge; thus the analysis focused only on the factor of how the exercise ended. The criteria set for the end factor grouping was as follows: 'negative end' was assigned when individuals responded with '-1' or lower on the '-5' to '5' FS scale and, 'no negative end' for individuals who responded 1 or higher on the FS scale.

Low intensity condition. Exploratory analyses revealed uneven group sizes for the two conditions; the 'negative end' group totalled 5 individuals, the 'no negative end' totalled 35 participants. Hence the assumption of equal group sizes underlying subsequent statistical analyses was violated, therefore further analyses with participants in the low intensity condition were not undertaken.

High intensity condition. Exploratory analysis revealed group sizes that could be comparable in the two conditions; specifically, 'negative end' (n = 21) and 'no negative end' (n = 19). The subsequent analyses independent samples t-tests revealed significant differences in the two groups at recall at 24 hrs $t(38) = 4.23$, $p = .000$; and 48 hrs $t(38) = 3.76$, $p = .001$. For the descriptive data please see table 1.6.

Table 1.6

Mean and SD recall measure (GAE) for 'Negative end' and 'no Negative end' groups.

	'Negative end' group Mean (*SD*)	'No negative end' group Mean (*SD*)
24hr recall	-.62 (4.98)	4.87 (3.09)
48hr recall	.18 (5.13)	5.25 (3.28)

5.4 Discussion

The aim of the present study was to examine links between the affective experiences of exercise, how individuals recall their affective experience, and anticipatory feelings to exercise. The results indicate that recall of affective experience from exercise continue to fluctuate after exercise is terminated regardless of whether the exercise intensity is low or high. Therefore, these findings contrast with the commonly held presumption that post exercise affect remains constant after exercise is completed. However, these results are in line with research which suggest that affective memory from exercise experiences are comprised of information that contradicts with the affective experience during the exercise itself (Hargreaves, & Stych, 2013). Moreover, in line with previous studies the results showed that high intensity exercise was evaluated less positively than low intensity exercise (Ekkekakis, 2003). These findings are also in line with the research which linked experience of exercise with adherence showing that percentages of people who exercise

with high intensity exercise experience the exercise less positively and have significantly lower rates of adherence than those who exercise with a low or a moderate intensity (DaSilva et al, 2011).

In relation to the examination of the peak and end rule and specifically the 'negative end', we found significant results in the high intensity condition which are in line with previous research findings (Brewer, Manos, McDevitt, Cornelius, & Van Raalte, 2000). This may offer a contribution to understanding the affect-adherence link showing that the negative affect at the end of exercise, especially for a high intensity exercise (where the negative valence is particularly adverse) is followed by distinctly lower recall of exercise experience.

A key result from this study indicates that the recall of affective responses declined in reported valence significantly at the 24 hrs post exercise measurement point. Research literature offers two potential explanations for such a decrease in the recall of affective responses at 24 hr post exercise, where one is a termination of the anxiolytic effect from exercise (Ebbesen, et al., 1992; Kwan, & Bryan, 2010; Salmon, 2001) and another relates to the Delay Onset Muscle Soreness phenomenon (DOMS; Cheung, Hume, & Maxwell, 2003).

A study by Ebbesen et al., (1992) highlighted that exercise attenuates perceived stress at 1 hour and 3 hrs after exercise, but the effect does not extend to 24 hrs. Kwan and Bryan demonstrated that after a submaximal bout of exercise, individuals' levels of tranquillity raised above the baseline level. Alas the measurement was taken only at 15 and 30 minutes post exercise, the effect of the raised tranquillity was maintained across the two measurement points. Kwan and Bryan concluded that if such increase of feelings of tranquillity persisted throughout the day there might be a particularly important hedonic benefit from engaging in exercise simultaneously demonstrating stress-reduction

effects of regular exercise behaviour. A study by Salmon (2001) also indicated on the important role of anxiolytic effect of exercise, yet there was no follow-up measurement reaching the 24 hr post exercise. Considering the aforementioned research, it appears that perceived stress may be an important factor that moderates the evaluation of exercise related affect during recall at later measurement points.

The other possible explanation for the study's result may be an occurrence of Delay Onset Muscle Soreness (DOMS; Cheung, Hume, & Maxwell, 2003) which refers to the muscular pain and swelling that follows unaccustomed exertion and it tend to occur approximately from 4 to eight hrs after the exercise. Among individuals DOMS is described as a physical soreness and muscle ache. Thus, the participants in this study when recalling scoring affective experience during the 24 hr measurement point could possibly be biased by the presence of DOMS and the muscle soreness when evaluate how do they feel during the exercise. These explanations are two potential mechanisms underlying the drop at 24 hr in a recall of exercise induced affect. Further research is required to test these explanations.

Idiographic analyses aimed at evaluating individual responses for changes within circumplex space were undertaken; specifically whether individuals, during two exercise trials, remained in pleasant affective states or moved in the space in high/low exercise intensity condition to unpleasant affect were assessed. The magnitude of change within groups where participants improved their affective states, declined in affect, or experienced no change within the circumplex space was determineed. Further, recall of affective state was examined together with changes in feeling states for each group to elucidate potential links between affect experienced during exercise and its recall in the 2 weeks post measurement time. Overall, the three analyses highlighted a great deal of variability in affective states between individuals. In general, within the low intensity

exercise condition individuals experienced shifts in affective states that remained pleasant; one individual however, started the exercise with pleasant affect, shifted to unpleasant affect, and returned to the pleasant quadrant of the circumplex space before completing the exercise (Lp. 37). In the low intensity exercise condition, only five individuals remembered exercise as unpleasant at least once during the recall measurement, including the individual who returned from unpleasant to pleasant affect (Lp. 37). During high intensity exercise, a substantial number of participants (35%) shifted from pleasant feeling states and terminated exercise with unpleasant affect. Among those who shifted, the majority of individuals (71.4%) recalled exercise as an unpleasant experience. These findings reinforce the central feature of affect within the experience of exercise. During low intensity exercise individuals' experience pleasant affect and recall the exercise as pleasant; during high intensity exercise the unpleasant affect experienced is subsequently recalled and the overall memory of the exercise is evaluated as unpleasant. These findings may directly impact upon individuals' decision making and influence future behaviours (i.e., engaging in another bout of exercise; Williams, et al., 2008).

The idiographic analysis outline the magnitude of change individuals are prone to experience; a great deal of variability in affective states was observed, regardless of the exercise intensity. These findings are in line with previous research highlighting that individuals tend to vacillate within circumplex affective space during the exercise experience (e.g., Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007; Ekkekakis, Hall, & Petruzzello, 2008). Further, this study contributes to knowledge on the recall of exercise experience, indicating that the affect experienced during exercise is reflected in the recall of exercise experience over time. In particular, these findings are of note when considering the importance of memory in judgments and decision making which suggests

that individuals' preferences towards forthcoming behaviours are guided to a greater extend by a memory of the experience rather than experience itself (Hargreaves & Stych, 2013; Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Miron-Shatz, Stone, & Kahneman, 2009).

Numerous studies showed that long-term exercise is positively associated with positive affect during and after the exercise (Arent, et al., 2000; Schneider, et al., 2009) and that the affect as feedback can be a powerful motivational tool in exercise adherence that push us towards or away from the experience, depending on how we remembered the experience and how we anticipate the outcomes (Baumeister et al., 2007). In exercise it is common that once we finish the exercise and we feel good we may likely think of continuing the exercise in the following days. Contrary to planning however the actual decision for attending another bout of exercise may occur later than immediately after the exercise, for instance in the following days. The current study showed that the memory of affective experience in exercise is an important factor that contributes to how individuals construct their anticipatory feelings, consequently having an effect on their future behavioural choices. Findings obtained from the present study raise important applied implications for professionals aiming to optimise health and high performance and training programs designed to improve exercise adherence should consider the temporal fluctuations in recall of exercise related affect.

Although this study offers a contribution to the research of affect and exercise, there are a number of limitations that should be addressed. Firstly, the potential explanations offered in an attempt to account for the decline in recall of affective experience, namely the termination of anxiolytic effect of exercise and DOMS, are hypothetical since individuals who took part in the study were not specifically examined

for these effects. Thus, it would be important for future studies to undertake a physiological examination in order to assess whether individuals experience a termination of anxiolytic effect or delayed onset muscle soreness during post exercise evaluation. An additional limitation of this study lies within the idiographic analyses. Despite valuable information gained from the analyses there was a number of issues that were raised. Specifically, hence the lack of adequate existing methodology for analysing data from individual responses, some information could not be obtained. For example, since only a change in affective responses from the start (5th min) to an end (20th min) of an exercise was considered, the analysis of the two remaining measurement points, at 10th min and 15th min was discarded. This void in the method could not account for any changes of individuals who returned to the same affective state after shifting in circumplex space. Further, due to the grouping of recall responses (global affective evaluation) into positive (from "10" to "0") and negative (from "-1" to "-10"), smaller (yet potentially significant) changes could not be accounted for (e.g., changes from "9" to "0", Lp. 14). Similarly, the frequency of reported unpleasant recall could not be accounted for. This is an important shortcoming considering the consequence of experienced and recalled negative/unpleasant affect on future judgments and decision making (Baumeister et al., 2007; Schreiber & Kahneman, 2000; Tversky & Kahneman, 1992).

In order to enhance the contribution of new knowledge gained from this study, prospective studies may further examine when exactly (i.e., the time point) people make decisions to engage in another exercise bout. Correspondingly, succeeding studies may consider using a qualitative approach and more in depth enquiry to further examine recalled affective experience from exercise with a special emphasis on the 24 hr post exercise time point. Prospect studies may also examine if the 24 hr post exercise drop in recall of affective experience persists if individuals are participating in an extended

exercise program and have scheduled another exercise bout within the following days. It would also be important for subsequent studies to examine whether trends observed in the present study continue in more ecologically valid circumstances (i.e., during exercise undertaken at a self-selected intensity protocol).

The results of this study showed that individuals' affective experience of exercise and the recall of affective experience from exercise are not always corresponding; depending on the time of the measurement, the recall can be more or less positive. Another important insight from the study is that anticipatory feelings to exercise are better predicted by the recall of affective experience rather than actual affective experience of exercise. Tallying all the findings, this study provides insight into the design of more effective exercise interventions by supporting individuals at challenging the residuals from exercise. For that purpose, exercise practitioners are encouraged to raise awareness for post exercise declines in positive affect that may affect individuals' future exercise participation. Special emphasis should be placed on the 24 hrs post exercise period when the decline in recall of affective experience is the least positive.

6. Study 3: Effect of stress on recall of affective experience and anticipatory feelings to exercise associated with self-paced exercise intensity

6.1 Introduction

Physical activity and exercise have been forwarded as 'medicine' in the treatment of a number of globally increasing illnesses including diabetes mellitus, osteoporosis, heart failure and hypertension (Lee, Shiroma, Lobelo, Puska, Blair, & Katzmarzyk, 2012). In attempts to better understand the factors that contribute to the initiation and continuation of exercise behaviour, scholars have focused on the affective responses to exercise which are shown to perform a pivotal role in exercise participation (Berger & Owen, 1992; Ekkekakis, 2003; Kiviniemi, voss-Humke, & Seifert, 2007; Kwan & Bryan, 2010; Rose & Parfitt, 2010; Williams, 2008).

The previous study of this thesis outlined that an individual's experience and recall of exercise related affect is dependent on exercise intensity. Specifically, higher exercise intensity produced less positive affect followed by a greater decline in recall of affective experience relative to lower intensity exercise. Regardless of the intensity, the previous study indicated a significant decline in the recall of exercise related affect at 24hr post exercise. Furthermore, the results of the study identify a great variability between individuals, this highlights the importance of idiographic analysis. Additionally, the timing of the measurement of affect during exercise, and in the recall of exercise related affect, can influence individuals' reports. Taking into consideration the previous study's findings the current study aims to further investigate exercise related affect at different points in time with a special emphasis on anticipatory feelings and recall of the affective experience of exercise. The study also further investigates within subject factors, namely perceived and experienced stress; previously this was implied as a possible moderating factor in how individuals experience and recall exercise related affect. Moreover, to enhance ecological validity the current study examines affective responses

to exercise by employing a self-paced exercise protocol as opposed to an imposed exercise intensity.

The behavioural tendency to maximize pleasure and minimize displeasure advocated by the hedonic principle has been explored in exercise settings in the examination of adherence (e.g., Annesi, 2002, 2005; Berger & Owen, 1992; Klonoff, Annechild, & Landrine, 1994; Kwan & Bryan, 2010; Williams, et al., 2008). For example, in a longitudinal study by Williams and colleagues (2008) it was shown that the valence of affective responses to exercise could forecast exercise behaviour in 6 and 12 months' time. Although a number of studies have reported a positive relationship between affect and adherence (e.g., Kwan & Bryan, 2010; Williams, et al., 2008) other studies have not replicated these results (e.g., Annesi, 2002; Klonoff et al., 1994) and observed no associations between experienced affect and exercise adherence in follow up measurements. In review of the diverse findings across studies, Williams (2008) posited that the disparity found in studies' results may partially be attributed to different methodological approaches used in these studies examining the concept of basic affect and discrete emotions concomitantly.

In addition to the problematic use of diverse conceptualisations of affective responses to exercise (for a comprehensive review see Ekkekakis, 2012; 2013), the timing of the affect measurement comprising the data collection protocol may also contribute to divergent findings (Ekkekakis, Hall, & Petruzzello, 2008). Previously, research studies relied upon measures of affect collected prior to or post exercise, resulting in a common belief that physical activity primarily induced positive affective states (Yeung, 2006). Following advances in research design and refinement of measurement techniques, it was recognised that affective responses to exercise fluctuate both within and over time following a bout of exercise; specifically, exercise induced affect oscillates between

positive and neutral or even negative valence (Backhouse et al., 2007). These findings highlight that exercise is not purely a positive experience, and more detailed measurement of affect is required when making inferences about exercise and adherence (Ekkekakis, 2013; Ekkekakis & Petruzzello, 2000).

Related research of behaviours underpinning adherence has focused upon judgment and decision making in attempts to predict future actions (Ekkekakis, Hargreaves, & Parfitt, 2013; Kwan & Bryan, 2010; Nasuti & Rhodes, 2013). Specifically, studies have identified that the choices individuals make in the future are guided to a lesser extent by the actual previous experience, rather how the experience is recalled (Hargreaves & Stych, 2013; Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Miron-Shatz, Stone, & Kahneman, 2009) and the affective outcomes expected from the replication of the behaviour (Tversky & Kahneman, 1992; Kirsch, 1990; Mellers, Schwartz, & Ritov, 1999). Although recalled affective experience and anticipated affective responses have been shown to determine behaviours in various settings, within exercise this line of research has been the focus of limited research attention (Ekkekakis, Hall, & Petruzzello, 2013; Williams, 2008; Zenko, Ekkekakis, & Ariely, 2016). A related line of inquiry undertaken by Kilpatrick et al., (2009) compares individuals' anticipated perception of effort and their perceived effort reported prior to, and during a 30 min treadmill exercise session respectively; significant differences across pre, during and post exercise measurements were found. In particular, the trend across the data collected indicates that anticipated effort was largely overestimated when compared to the perceived effort recorded during the task. One potential explanation for these findings highlights research on the experience of pain where similar mechanisms were examined (e.g., Arntz, 1996; Rachman & Arntz, 1991) suggesting that inflated predictions of

anticipated exertion represent an effort to protect oneself against a surprising and potentially unpleasant level of exertion (Arntz, 1996; Rachman & Arntz, 1991).

More recent research in exercise settings exploring how affective experience is memorised highlights that the affective valence remembered from exercise does not accurately resemble the affective valence experienced during the exercise (Brewer et al., 2000; Hargreaves & Stych, 2013; Slawinska et al., under review). For example, Brewer et al., identified that exercisers do not accurately recall the duration of exercise, instead they remember how the exercise finishes. Hargreaves and Stych on the other hand found that individuals are prone to remember only the salient moments of an exercise experience, the positive or negative peaks and how the exercise was terminated, rather than an average of the entire experience. Previous study of this thesis in turn examined global affective evaluation (i.e., recall of affective responses to exercise) over a two weeks time period. The fluctuations were observed following completion of both a low-to-moderate and high intensity exercise sessions. The findings demonstrate that the recall of exercise induced affect varies post exercise with a significant worsening at 24 hours post-exercise, across both intensity conditions. One explanation for the robust drop in affective valence evaluation at 24 hours suggests an interaction of psychological and physiological adaptations that occur post-exercise (Gauvin, & Rejeski, 1993), in particular it is conjectured that the lowering of affective evaluation may be caused by the termination of the anxiolytic effects from exercise which are typically experienced by individuals in the form of attenuated stress and induced feelings of tranquillity (Broocks, et al., 1998; Raglin & Wilson, 1996; Salmon, 2001). According to a number of studies, the anxiolytic effect has been shown to extend from one to 8 hours post-exercise, with no detectable effects when measured 24 hours post-exercise (Ebbesen, et al., 1992; Gerber, Lindwall, Lindegard, Borjesson, & Jonsdottir, 2013).

Although numerous studies identify a strong association between exercise and reduced anxiety following aerobic and anaerobic exercise (e.g., Landers & Arent, 2001; Landers & Arent, 2007), multiple studies offer an alternative view of the exercise-anxiety relationship suggesting individuals experience increased levels of stress due to and prior to exercise (Stetson, Rahn, Dubbert, Wilner, & Mercury, 1997; Stults-Kolehmainen, & Sinha, 2014). For example, a study by Saanijoki et al., (2015) suggests that physiological responses to vigorous exercise may resemble perceived symptoms of anxiety where increased heart rate, shallow breathing, and muscle pain is interpreted as threatening and result in psycho-physiological stress (Wilmore & Costill, 1999) that could amplify aversive perceptions of exercise. State anxiety in turn describes an immediate psychological and physiological response to a perceived threat (Spielberger, 1983) and involves an emotional reaction or response that is induced when an individual perceives a particular situation as personally dangerous or frightening, irrespective of the presence or absence of real danger. Consequently, if a particular situation is interpreted as being threatening it is expected that elevated state anxiety will ensue, demonstrating itself through an unpleasant emotional state accompanied by feelings of tension, nervousness, and heightened autonomic system activity (e.g., increased heart rate & blood pressure, elevated cortisol and alpha amylase levels). These psycho-physiological increases may lead to perceptions of a less positive affective experience and/or avoidance behaviours.

Regarding physiological markers of experienced stress studies showed that the alpha amylase enzyme could be a reliable indicator that captures increases in response to physical and psychological stress (Koibuchi & Suzuki, 2014). Precisely, it was shown that catecholamine concentration measured via the secretion of salivary alpha-amylase has been determined to be a reliable indicator of sympathetic nervous system activity associated with increased emotional arousal (Granger, Kivlighan, El-Sheikh, Gordis, &

Stroud, 2007; Nater & Rohleder, 2009). Research comparing the response profiles of salivary alpha-amylase and salivary cortisol report distinct kinetic patterns (Granger et al., 2007). Specifically, the kinetic response profile of salivary alpha-amylase has been observed to reach its peak response and recover to baseline faster than the response profile of salivary cortisol (Dickerson & Kemeny, 2004). These kinetic patterns are in keeping with the physiological differences of the sympathetic nervous system (measured by salivary alpha-amylase) and the hypothalamic-pituitary-adrenal axis (measured by salivary cortisol; see Granger et al., 2007). Therefore, salivary alpha-amylase may offer a more appropriate measure of physiological arousal during exercise tasks of a short duration than salivary cortisol, as the kinetic profile of salivary alpha amylase is more responsive.

In summary, in consideration of previous research, we hypothesized that the recall of affective responses to exercise would fluctuate over time and a reduction of recalled positive affect would be reported 24 hours following exercise. In aiming to maximize the ecological validity of the study and optimize the feeling states associated with exercise, we employed a self-paced exercise protocol as a self-determined exercise pacing strategy has been shown to enhance affective response and minimize the potential of introducing additional stress associated with the difficulty of the task for less active participants (Ekkekakis & Lind, 2006; Parfitt, Rose, & Burgess, 2006; Williams, 2008). In this study, we sought to explore whether fluctuations in the recall of affective experience from exercise would be present in a self-selected intensity exercise protocol as was previously documented in studies with prescribed intensities. Moreover, in order to examine whether the decline in affective evaluation at 24 hours following the completion of exercise can be partially explained by termination of the anxiolytic effect and increased levels of perceived and experienced stress, we recorded self-reported perceptions of stress, state

anxiety and a biological marker of stress (i.e., alpha amylase enzyme). We hypothesized that psycho-physiological markers (i.e., state anxiety and alpha amylase) measured at 24 hours post exercise will be higher when compared to baseline levels. Further, we expected that individuals who perceive higher levels of stress would anticipate the affective outcome of exercise less favourably than those who appraise their lives as less stressful.

6.2 Methods

6.2.1 Participants

The study sample consisted of 25 adults (13 females, 12 males), M_{age} = 29.2, SD = 4.34, including students (N = 8; 32%) and non students (N = 17; 68%); at the time of the study they did not suffer from any physical injury, had no history of cardiovascular or respiratory disease and were physically capable of engaging in moderate exercise. Participants were recruited via advertisement emails and posters displayed on the University's campus notice boards as well as a fitness centre in the UK. Upon agreement to take part in the study participants signed an informed consent form. The ethical approval for the study was gained from the University where the data collection was undertaken.

6.2.2 Measures

Exercise behaviour. Current exercise behaviour was measured using the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985; Appendix X). The LTEQ has been previously used to assess how frequently participants undertake more than 20 min of mild, moderate, and strenuous exercise during their free time in a typical week calculated by metabolic equivalents (METs; mild x 3 + moderate x 5 + strenuous x 9).

Affect. The affective valence and perceived activation dimensions of the circumplex model of affect (Russell, 1980) were assessed by two single-item scales. The affective valence dimension has been assessed by the Feeling Scale (FS; Hardy & Rejeski, 1989), which entails an 11 point bipolar measurement scale of pleasure-displeasure, ranging from +5 *(I feel very good)* to -5 *(I feel very bad)*. The perceived activation dimension was assessed by the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985) on a 6-point scale ranging from 1 *(low arousal)* to 6 *(high arousal)*.

Recall of affect. The recalled affective experience was measured with the Global affective evaluation scale (GAE; Schreiber & Kahneman, 2000) which has been previously used to measure the overall amount of pleasantness or unpleasantness that was experienced during exercise (Hargreaves & Stych, 2013) using a scale ranging from -10 *(very unpleasant experience)* through 0 *(neutral experience)* to +10 *(very pleasant experience)*.

Anticipatory feelings. Anticipatory feelings were measured by 1 item scale, worded: "Please rate the overall amount of pleasantness or unpleasantness you expect to feel in the upcoming exercise trial on a scale ranging from -10 *(very unpleasant experience)* through 0 *(neutral experience)* to +10 *(very pleasant experience)*. The measure was collected immediately before the exercise bout.

State Anxiety. State Anxiety was assessed with the State Anxiety Inventory (STAI; Spielberger, 1983; See Appendix O) which measured current state of anxiety by asking how respondents feel "right now," using items that measure subjective feelings of apprehension, tension, nervousness, worry, and activation/ arousal of the autonomic nervous system. In the current study, the short version of the scale was used consisting of

6 items instead of the original 20. The short version of the scale has been previously used and validated (Marteau & Bekker, 1992).

Perceived stress. The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983; See Appendix N) was used to measure participants' self-appraised stress and the frequency of stress experiences. Items in the PSS were designed to assess how predictable, uncontrollable and overloading participants consider their lives. This measure consists of 10 items rated on a 5 point Likert-type scale from 0 ("*never"*) to 4 ("*very often*"). This questionnaire has been reported to have good construct validity (Cohen & Williamson, 1988).

Perceived exertion. The Borg 6–20 Rating of Perceived Exertion scale (Borg, 1998) was used to assess whole-body ratings of perceived exertion (RPE). In line with recommendations (Borg, 1998), participants were given standardised instruction on how to use the scale and had time to practice during the familiarization session. Participants were instructed: "*While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you reflecting on your total feeling of exertion. Choose the number from below that best describes your level of exertion"*.

Biological measure of stress

Salivary samples were collected to determine alpha-amylase levels at a baseline level and across the experimental conditions (i.e., before two exercise trials and during the 24 hr post exercise period). All samples were collected at exactly the same time of the day and

participants were asked to follow strictly provided instructions on how to sample the saliva. Participants provided two saliva samples via a passive drool collection for five minutes (Rohleder, Wolf, Maldonado & Kirschbaum, 2005). Immediately after each collection point, saliva samples were stored in a freezer at – 45° C until biochemical analysis were undertaken. During the analysis, saliva tubes were centrifuged for 10 min at 3,000 rpm to obtain clear saliva. Saliva volume was estimated by weighing to the nearest milligram and the saliva density was assumed to be 1.0 g ml-1 (Cole & Eastoe, 1988). Saliva flow rate (ml min-1) was determined by dividing the volume of saliva by the collection time. Salivary alpha-amylase was assayed using kits (Alpha-amylase assay kit; Salimetrics Inc., State College, PA, USA), and alpha-amylase activity was expressed as international units per milliliter of saliva.

6.2.3 Procedure

Individuals who volunteered to participate in the study were scheduled for testing trials and confirmed their availability for the study arranging to attend the laboratory on four consecutive days at exactly the same time of the day. Prior to the testing participants were instructed to not eat, and drink beverages containing caffeine or fruit juices at least 120 min before each visit, inducing the first, introductory visit, and to avoid drinking alcohol at least 24 hours prior to visiting the lab. On the scheduled days participants were invited to a lab for an introductory session and were briefed on the procedure of the study, exercise trial, and self-selected intensity protocol. Once they read the information sheet and agreed to participate in the study informed consents forms were obtained, one for the study participation and one for providing bodily samples as required by the University policy. Baseline measures collected during the first visit included demographic measures

of age, gender and occupation, body measurements including weight and height followed by saliva sampling and then psychological measures of LTEQ, FS, FAS, PSS, STAI measures and anticipatory feelings for an upcoming exercise trial. Exactly 24 hours later participants returned to the laboratory for the second visit and were asked to fill in current feeling measures (FS, FAS), the anticipatory feelings measure, and the STAI measure. Next participants were asked to provide a sample of saliva. Once all the measures were collected the exercise trial started and individuals were instructed to warm-up for 3 min by setting a treadmill on a comfortable walking pace before changing to moderate exercise intensity for the 20 min run. Participants were reminded on what the moderate intensity exercise should feel like in line with the guidelines and physical activity recommendation (The national guidelines on physical activity for Ireland (www.getirelandactive.ie, p.15). Participants were informed that they could change the exercise intensity every 2 min to maintain the moderate intensity exercise. During the exercise trial, every 5 min, participants were asked to provide measures of current feeling (FS), arousal (FAS) and perceived exertion (BORG 20), the exact timings for these measurements were 5 min, 10 min, 15 min, and 19.5 min into the exercise trial. Once the 20 min run was completed participants were asked to cool down for another 3 min by reducing the treadmill speed rate to a walking pace. Immediately after the cool down participants were asked to fill in the FS and FAS scales and the global affective evaluation scale (GAE). Next, participants were informed to provide responses to the follow-up measurement points at 4 hrs and 8 hrs by replying timely to text messages and proving their responses to FS, FAS, and GAE measures. At exactly 24 hrs after the second visit participants were asked to return to the laboratory for the third visit to provide their scores on GAE scale, as well as sample of saliva together with measures on FS and FAS, the

anticipatory feelings to an upcoming exercise trial which was scheduled for the next day and the STAI measure. During the final fourth visit in the laboratory at exactly 24 hrs after the third visit participants were asked to follow the same sequence of activities as during the second visit. Additionally, participants were asked to continue the follow-up measurement throughout 24 hrs and 48 hrs post exercise trial. Once all the follow-up measures were completed participants were asked to return to the laboratory where they were debriefed and received payment for their participation in the study.

Statistical analysis

Repeated Measure ANOVAs were conducted to investigate whether there were differences in within-subject levels in anticipatory feelings, recall of affect and state anxiety across the conditions. Further, repeated measures ANOVA tested for differences in scores before/after the exercise trials, where there was no exercise and before/after the trial with a bout of exercise. In order to determine these differences, the within subject repeated contrast was used as it compares the mean of each level to the mean of the subsequent level, as it was the objective of this study. The contrasts analysis compares pairs of levels from the multiple levels, its choice of levels being specified in the options of SPSS. When there is a reliable difference in simple contrasts but not in main effect, the results are indicating that a pair of the levels considered alone would show a difference.

6.3 Results

Descriptive statistics on participants' age, weight, height and exercise history are presented in table 1.7.

Table 1.7

Descriptive Statistics on Participants' Baseline Information

	M	(*SD*)
Age (years)	29.2	(4.34)
Weight (kg)	66.86	(15.26)
Height (cm)	170.84	(9.01)
BMI	22.68	(3.43)
Exercise behaviour (LTEQ; METS/week)	43.24	(17.22)

Analysis of variance showed within-subject effect of time on anticipation, $F(3, 24) = 3.64$, $p < .05$, $\eta_p^2 = .13$. Within-subject repeated contrasts revealed differences between levels with a significant difference between 1st visit, the baseline visit and the 2nd visit, the 1st exercise trial, $F(1, 24) = 8.30$, $p < .01$, $\eta_p^2 = .26$, and a significant difference between the 2nd visit, the 1st exercise trial and the 3rd visit, 24hr control visit, $F(1, 24) = 7.06$, $p < .05$, $\eta_p^2 = .23$. See table 2 for descriptive statistics for anticipation measure at different measurement points.

Table 1.8

Descriptive Statistics for the Anticipation Measurement

Time	*M*	*SE*	95% Confidence Interval	
			Lower Bound	Upper Bound
Baseline	5.64	.55	4.50	6.78
Before 1st exercise	4.16	.68	2.75	5.57
24 hrs	5.28	.51	4.22	6.34
Before 2nd exercise	5.04	.57	3.86	6.22

Results from repeated measures ANOVAs showed within-subject effect of time on recalled affect (GAE) after the first exercise trial approaching level of significance $F(3, 24) = 3.18$, $p = .051$, $\eta_p^2 = .12$, and significant effect on recalled affect (GAE) from second exercise trial $F(4, 24) = 3.66$, $p < .05$, $\eta_p^2 = .13$. See table 1.6 for descriptive statistics for

the recall measure at different measurement points. Trends of the data on recall of affective experience from the first trial of exercise and the second trial of exercise are illustrated in Figure 1.3 and Figure 1.4 respectively.

Table 1.9

Descriptive Statistics for the Recall of Affective Experience (GAE)

Recall time		*M*	*SE*	95% Confidence Interval	
				Lower Bound	Upper Bound
1st exercise	1 min post	6.12	.46	5.18	7.06
	4 hrs	5.44	.57	4.27	6.61
	8 hrs	5.12	.54	4.01	6.23
	24 hrs	5.20	.53	4.10	6.30
2nd exercise	1 min post	5.96	.58	4.77	7.15
	4 hrs	5.44	.56	4.29	6.59
	8 hrs	5.40	.57	4.22	6.58
	24 hrs	4.84	.65	3.48	6.19
	48 hrs	4.76	.66	3.40	6.12

Repeated measures ANOVA showed no significant changes in current affect during the first exercise trial $F(3, 24) = .765, p = .47$. There was no significant changes during current affect during the second exercise trial either $F(3, 24) = 2.59, p = .11$.

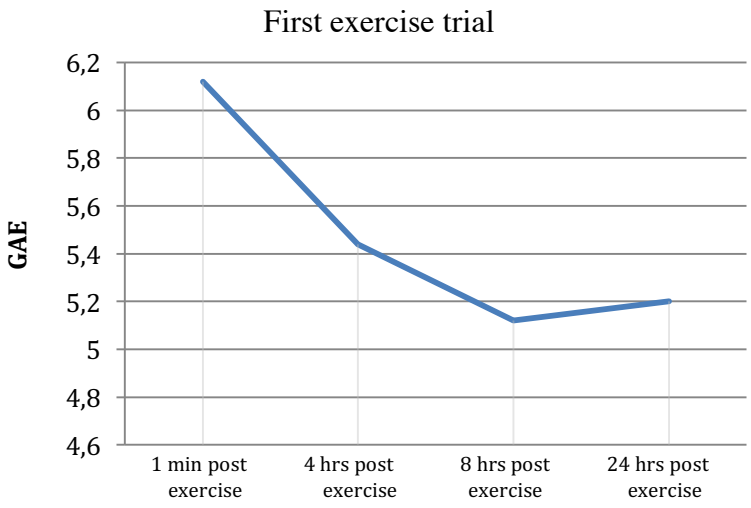


Figure 1.13. Recalled affect from exercise from the first exercise trial.

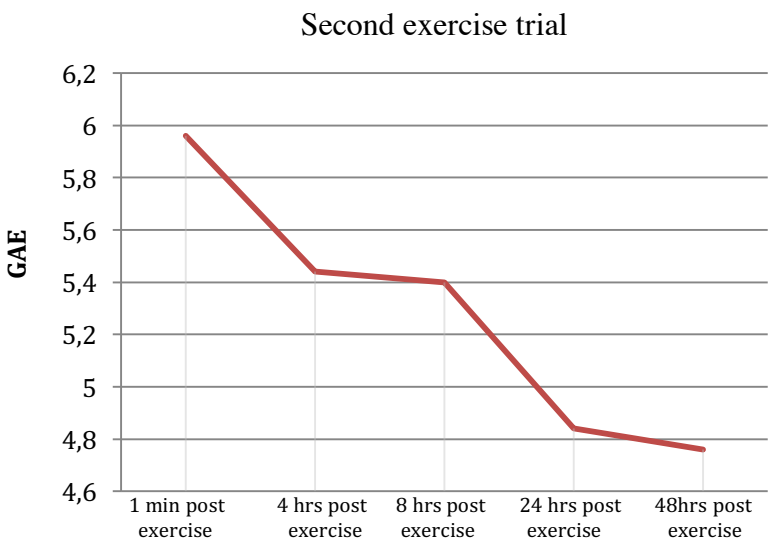
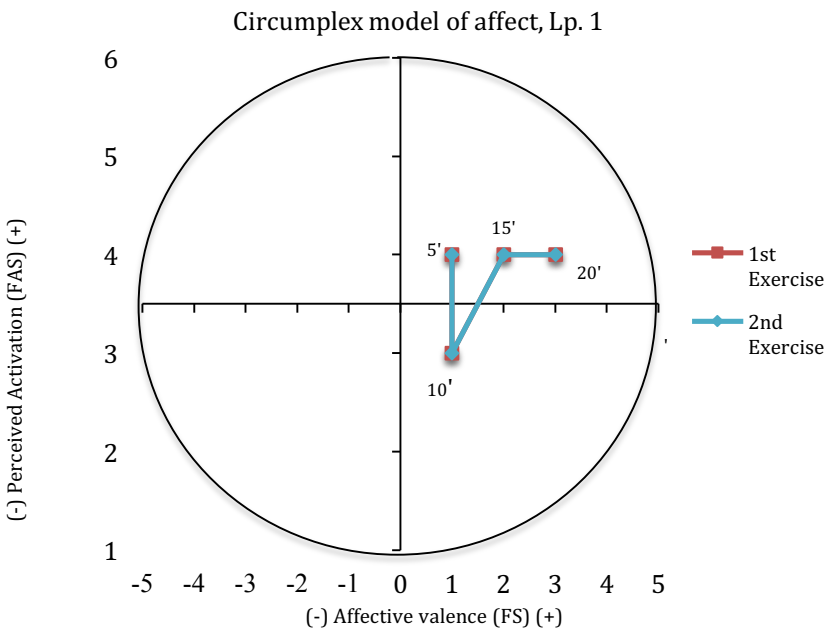


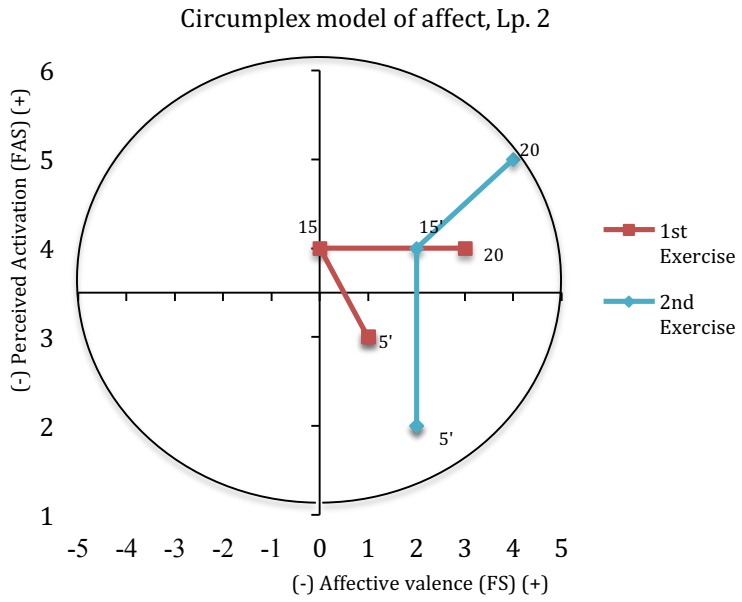
Figure 1.14. Recalled affect from exercise from the second exercise trial.

Idiographic analysis - Circumplex model

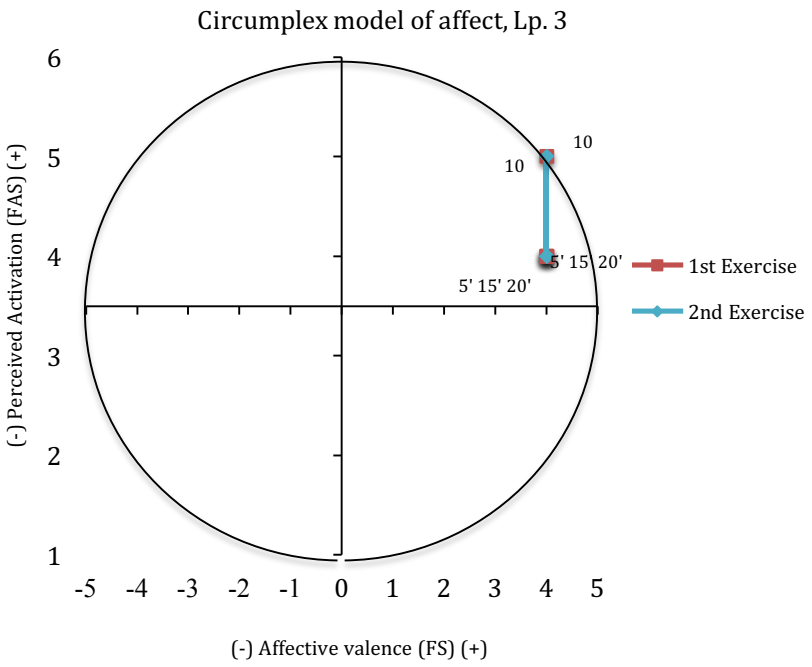
Individuals' affective responses for two exercise sessions were plotted on Circumplex space with affective valence (FS) and perceived activation (FAS). The idiographic analysis was supplemented with individuals' global affective evaluation for each of the measurement time. Please see Circumplex space graphs in Figure 1.15.



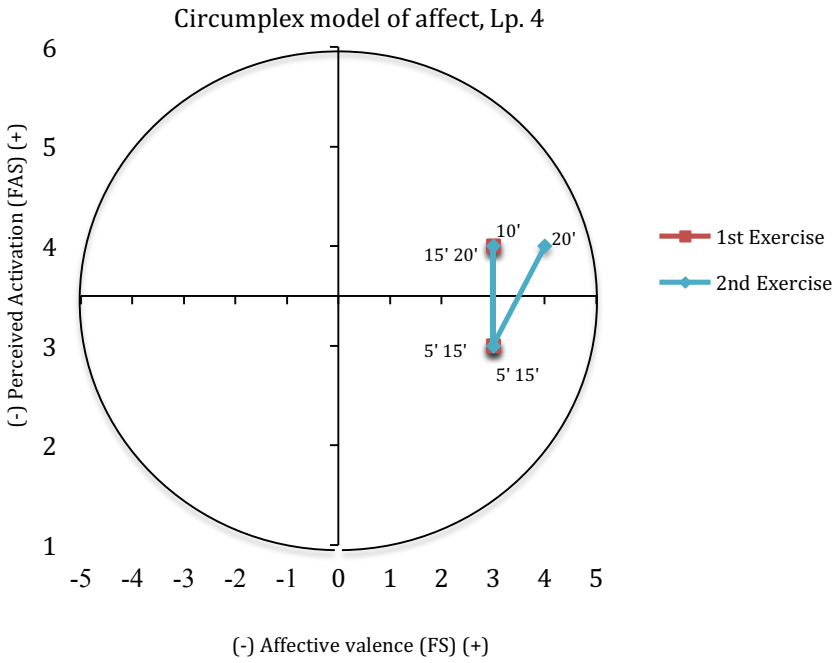
1st exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 8, GAE 8hrs = 7, GAE 24hrs = 8.
2nd exercise Global affective evalaution (GAE): GAE 1' = 4, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 8, GAE 48hrs = 5.



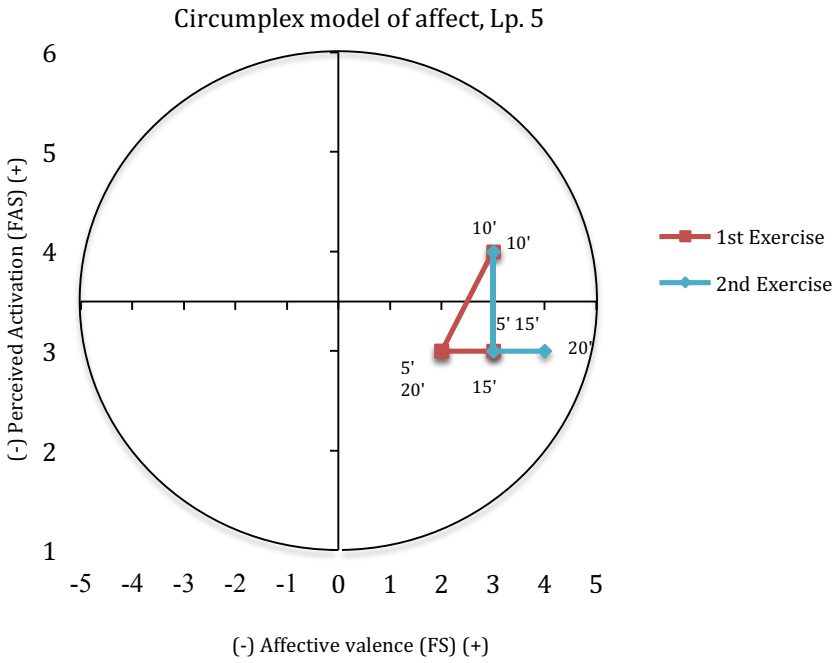
1st exercise Global affective evalaution (GAE): GAE 1' = 4, GAE 4hrs = 2, GAE 8hrs = 3, GAE 24hrs = 4.
2nd exercise Global affective evalaution (GAE): GAE 1'= 4, GAE 4hrs = 2, GAE 8hrs = 2, GAE 24hrs = 0, GAE 48hrs = 2.



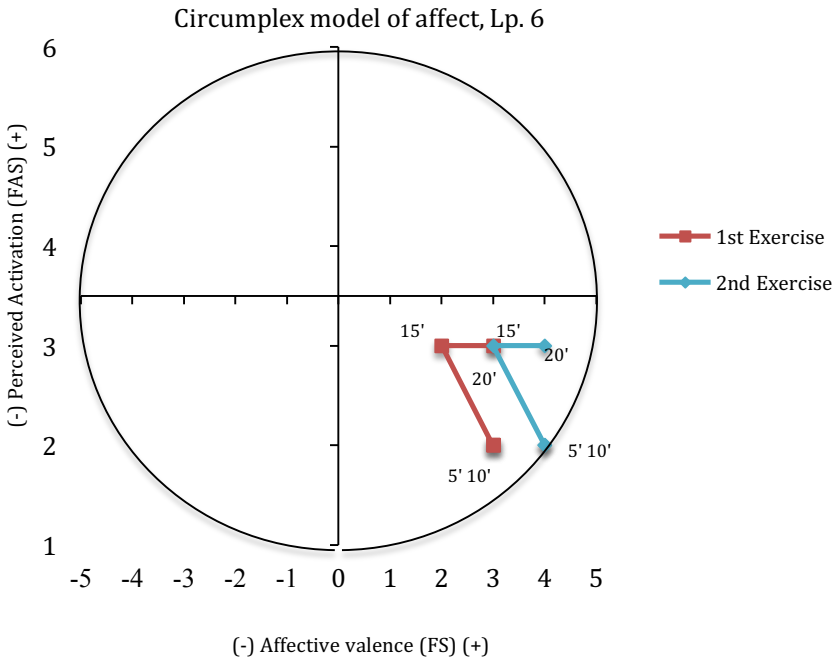
1st exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 8, GAE 8hrs =6, GAE 24hrs = 7.
2nd exercise Global affective evalaution (GAE): GAE 1' = 7, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 6, GAE 48hrs = 7.



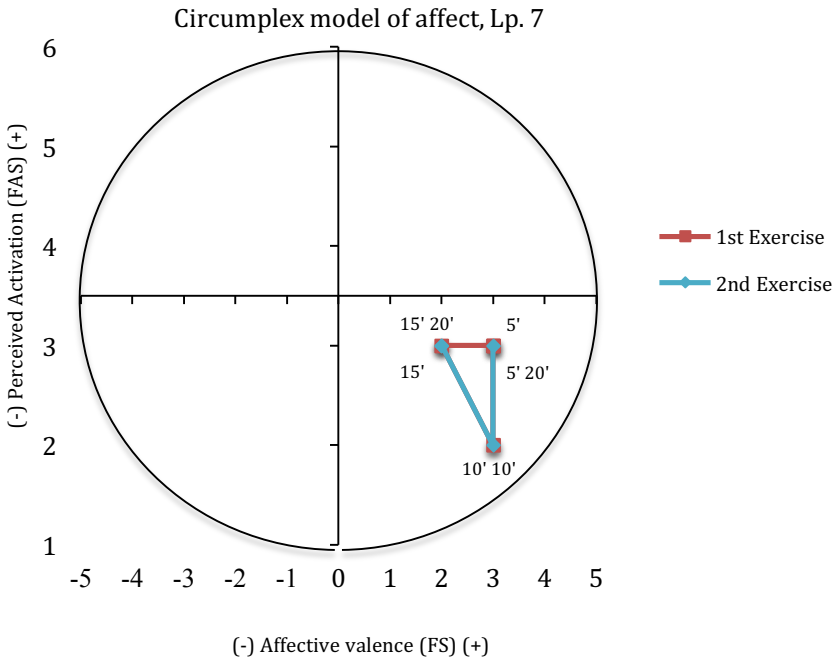
1st exercise Global affective evalaution (GAE): GAE 1' = 6, GAE 4hrs = 2, GAE 8hrs = 0, GAE 24hrs = 6.
2nd exercise Global affective evalaution (GAE): GAE 1' = 6, GAE 4hrs = 0, GAE 8hrs = 6, GAE 24hrs = 3, GAE 48hrs = 4.



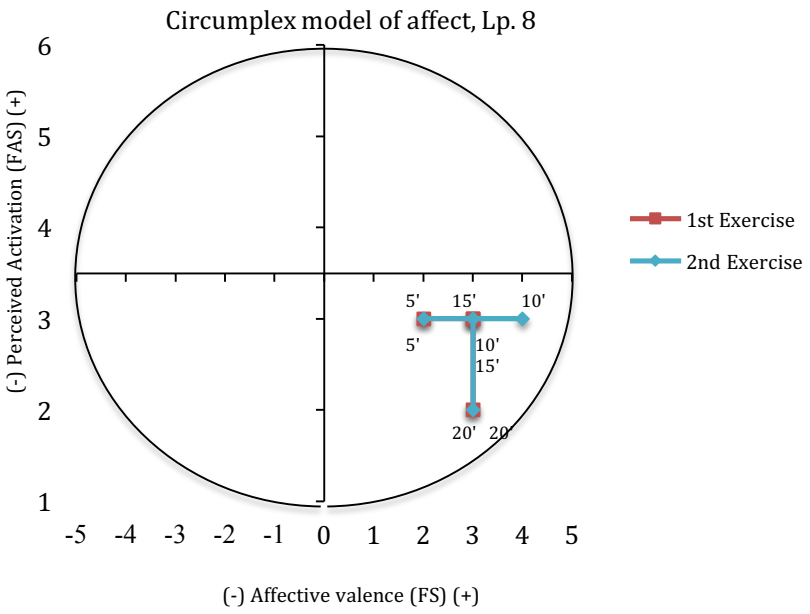
1st exercise Global affective evalaution (GAE): GAE 1' = 3, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 5.
2nd exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 7, GAE 8hrs = 7, GAE 24hrs = 7, GAE 48hrs = 7.



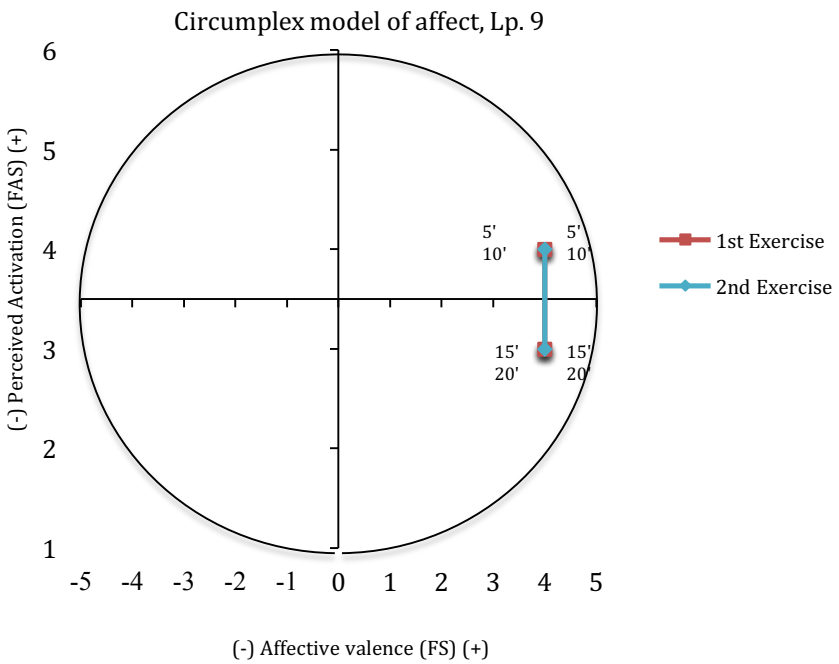
1st exercise Global affective evalaution (GAE): GAE 1' = 7, GAE 4hrs = 5, GAE 8hrs = 4, GAE 24hrs = 2.
2nd exercise Global affective evalaution (GAE): GAE 1' = 7, GAE 4hrs = 5, GAE 8hrs = 5, GAE 24hrs = 3, GAE 48hrs = 2.



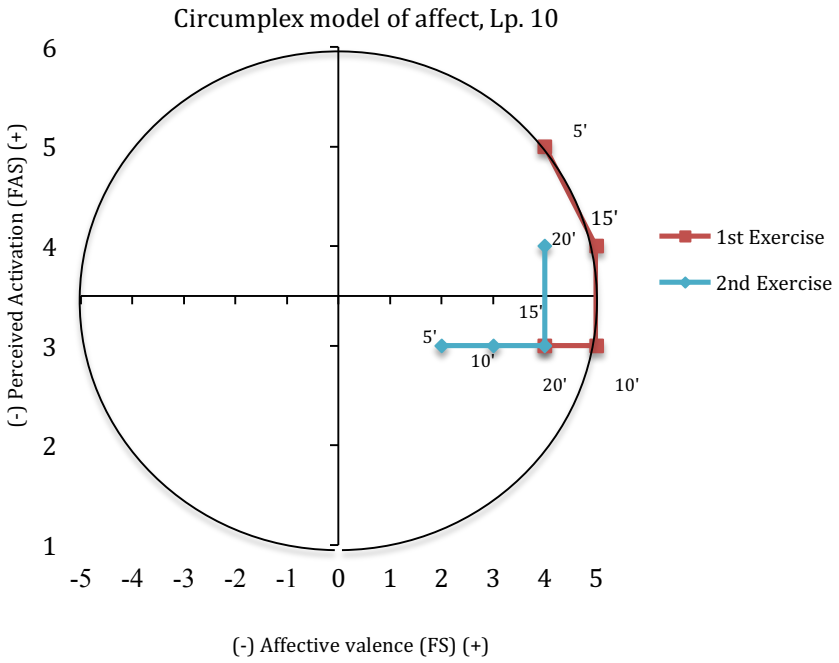
1st exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 5, GAE 8hrs = 4, GAE 24hrs = 1.
2nd exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 5, GAE 8hrs = 5, GAE 24hrs = 0, GAE 48hrs = -2.



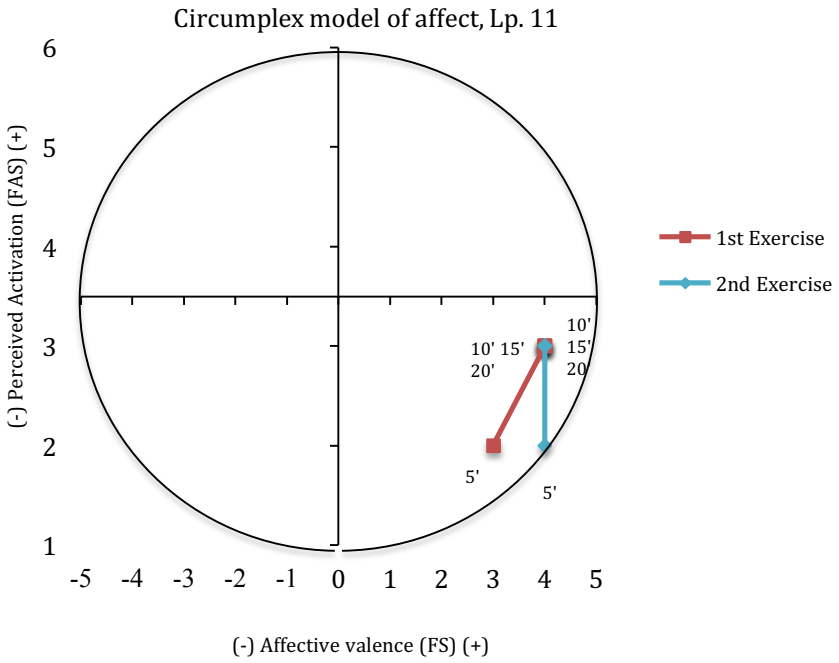
1st exercise Global affective evalaution (GAE): GAE 1' = 9, GAE 4hrs = 7, GAE 8hrs = 6, GAE 24hrs = 8.
2nd exercise Global affective evalaution (GAE): GAE 1' = 9, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 8, GAE 48hrs = 7.



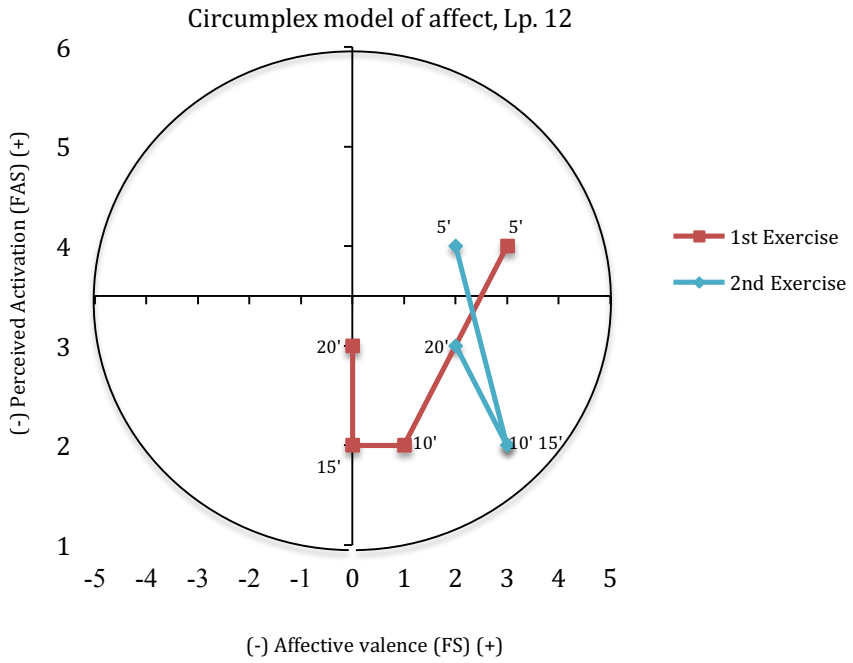
1st exercise Global affective evalaution (GAE): GAE 1' = 6, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 7.
2nd exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 8, GAE 48hrs = 8.



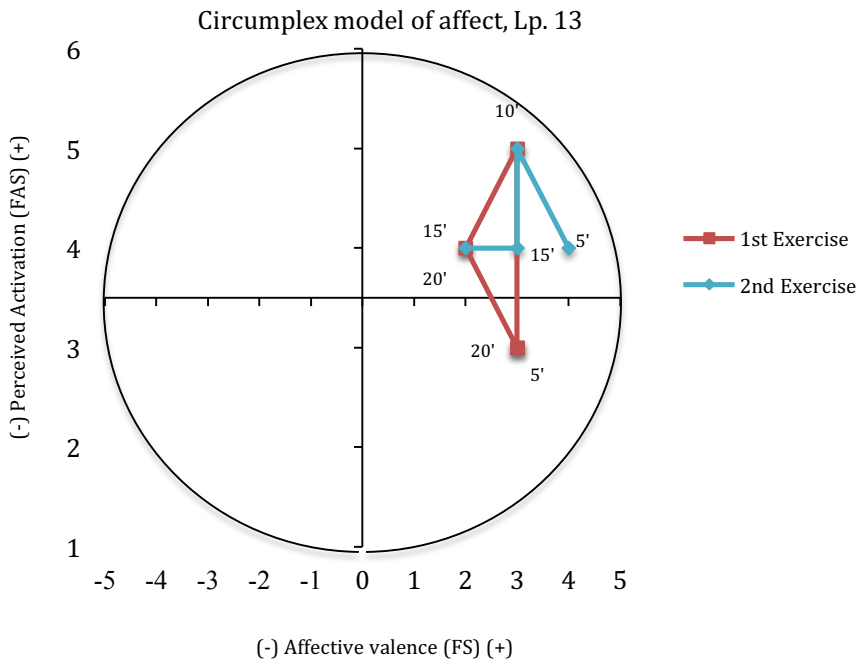
1st exercise Global affective evalaution (GAE): GAE 1' = 10, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9.
2nd exercise Global affective evalaution (GAE): GAE 1' = 9, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 9.



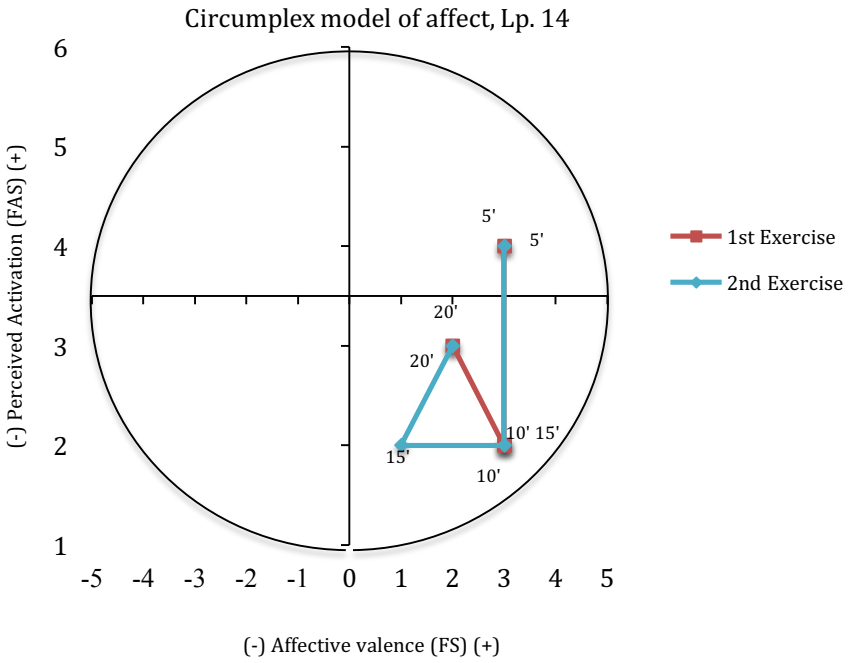
1st exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 8.
2nd exercise Global affective evalaution (GAE): GAE 1' = 9, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 8, GAE 48hrs = 8, GAE 1wk = 8, GAE 2wks = 8.



1st exercise Global affective evalaution (GAE): GAE 1' = 3, GAE 4hrs = 2, GAE 8hrs = 0, GAE 24hrs = 3.
2nd exercise Global affective evalaution (GAE): GAE 1' = 3, GAE 4hrs = 0, GAE 8hrs = 2, GAE 24hrs = 1, GAE 48hrs = 2.



1st exercise Global affective evalaution (GAE): GAE 1' = 6, GAE 4hrs = 7, GAE 8hrs = 6, GAE 24hrs = 7.
2nd exercise Global affective evalaution (GAE): GAE 1' = 5, GAE 4hrs = 5, GAE 8hrs = 5, GAE 24hrs = 5, GAE 48hrs = 5.



1st exercise Global affective evalaution (GAE): GAE 1' = 2, GAE 4hrs = -2, GAE 8hrs = 2, GAE 24hrs = 2.
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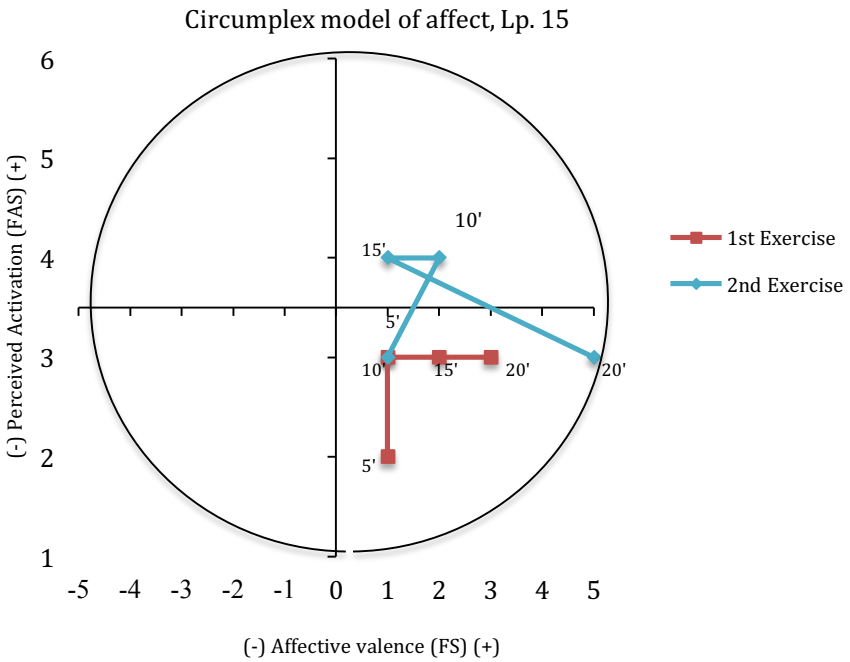
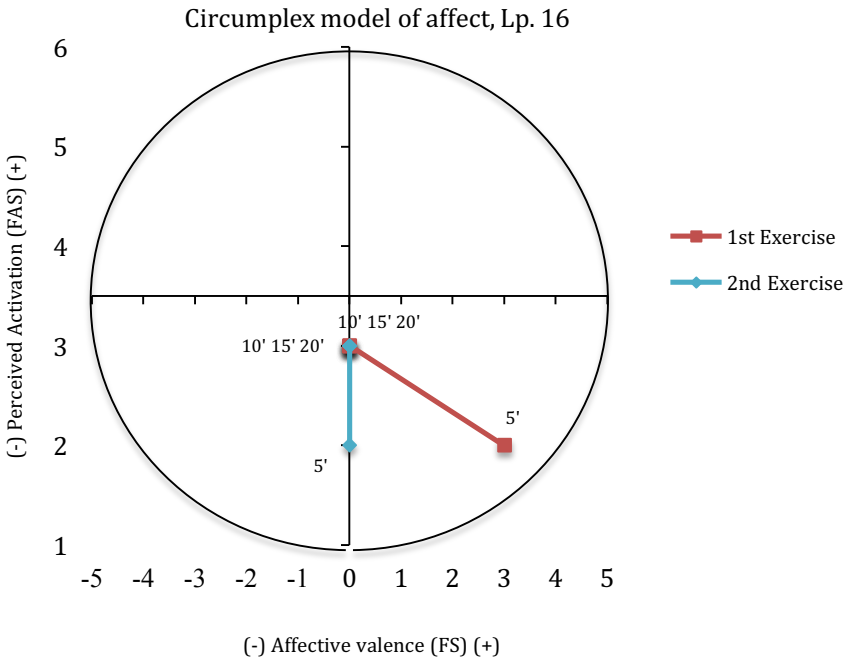
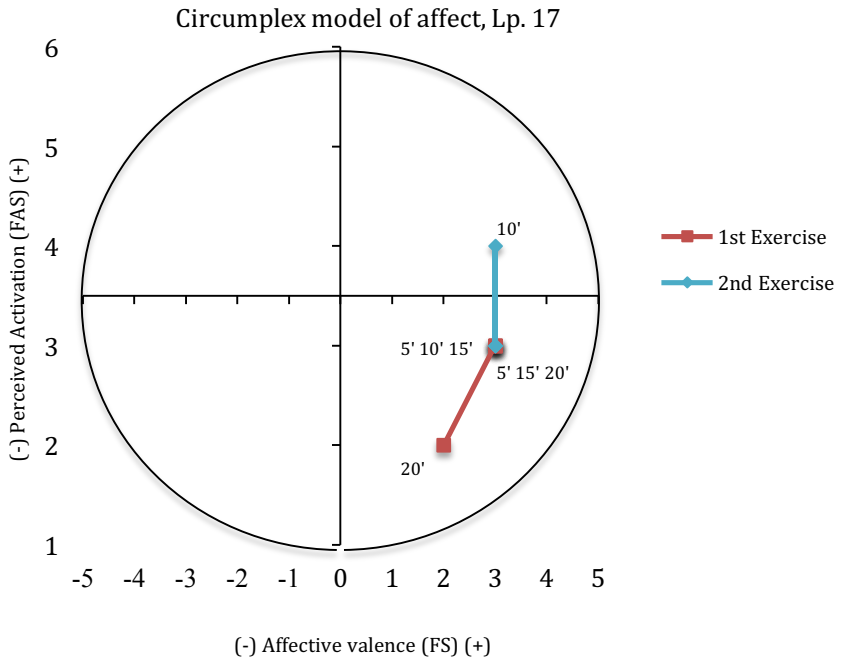


1st exercise Global affective evalaution (GAE): GAE 1' = 6, GAE 4hrs = 5, GAE 8hrs = 6, GAE 24hrs = 5.
2nd exercise Global affective evalaution (GAE): GAE 1' = -2, GAE 4hrs = 2, GAE 8hrs = -2, GAE 24hrs = -2, GAE 48hrs = -3.



1st exercise Global affective evalaution (GAE): GAE 1' = 4, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 3.
2nd exercise Global affective evalaution (GAE): GAE 1' = 4, GAE 4hrs = 4, GAE 8hrs = 3, GAE 24hrs = 4, GAE 48hrs = 4.



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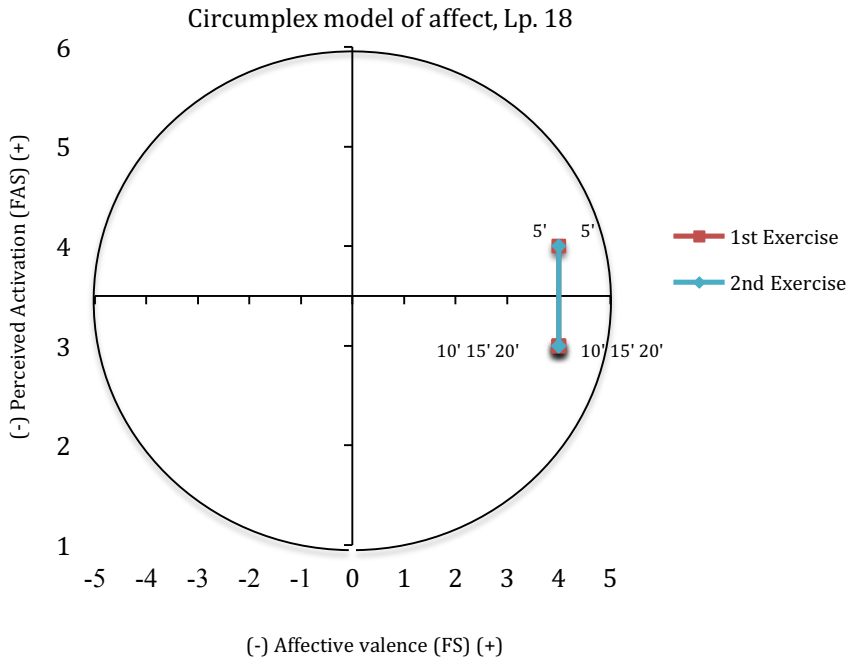
2nd exercise Global affective evalaution (GAE): GAE 1' = 7, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 9.



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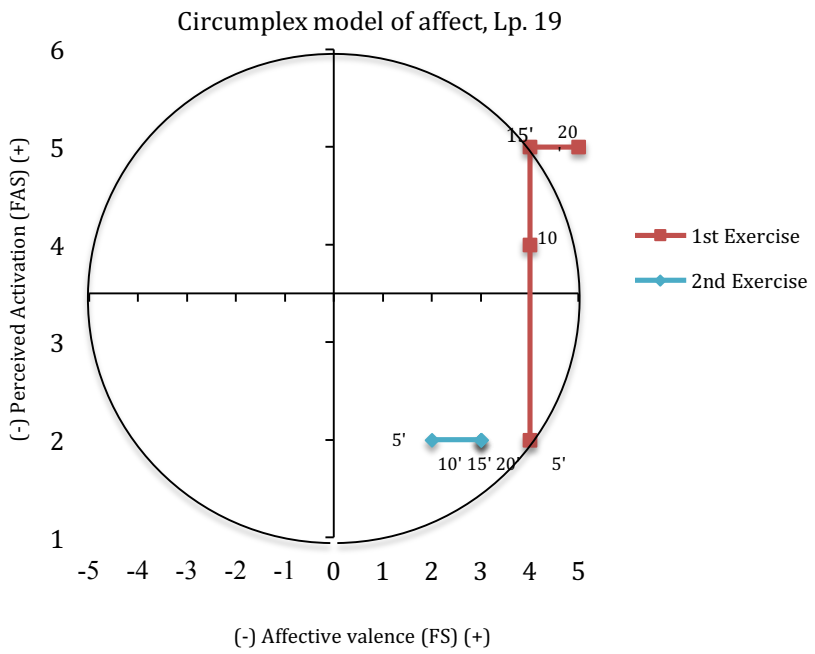
2nd exercise Global affective evalaution (GAE): GAE 1' = 6, GAE 4hrs = 5, GAE 8hrs = 4, GAE 24hrs = 4, GAE 48hrs = 4.



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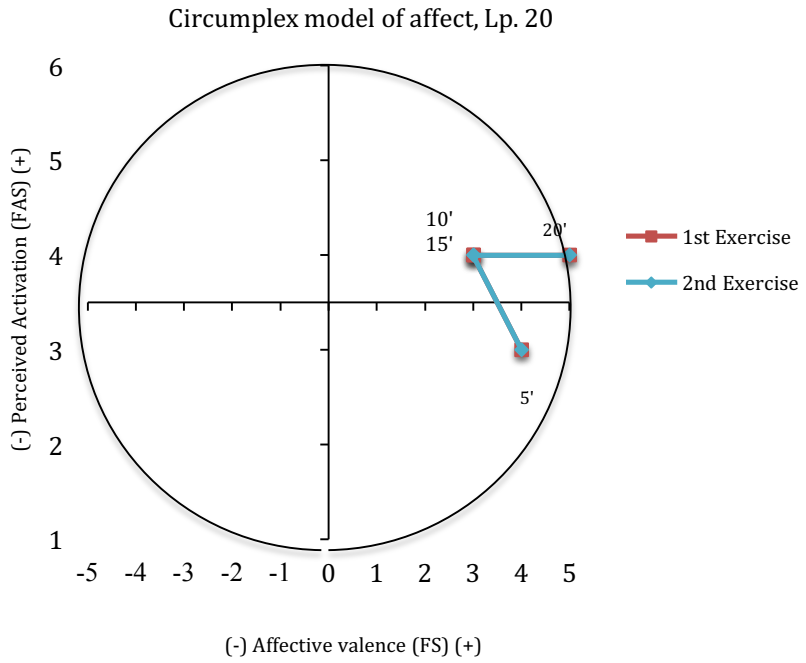
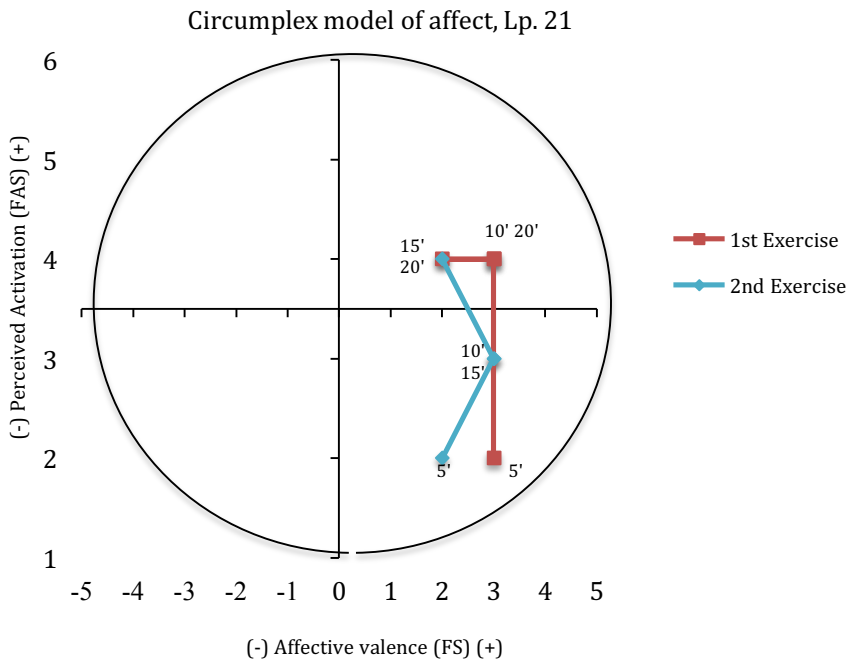
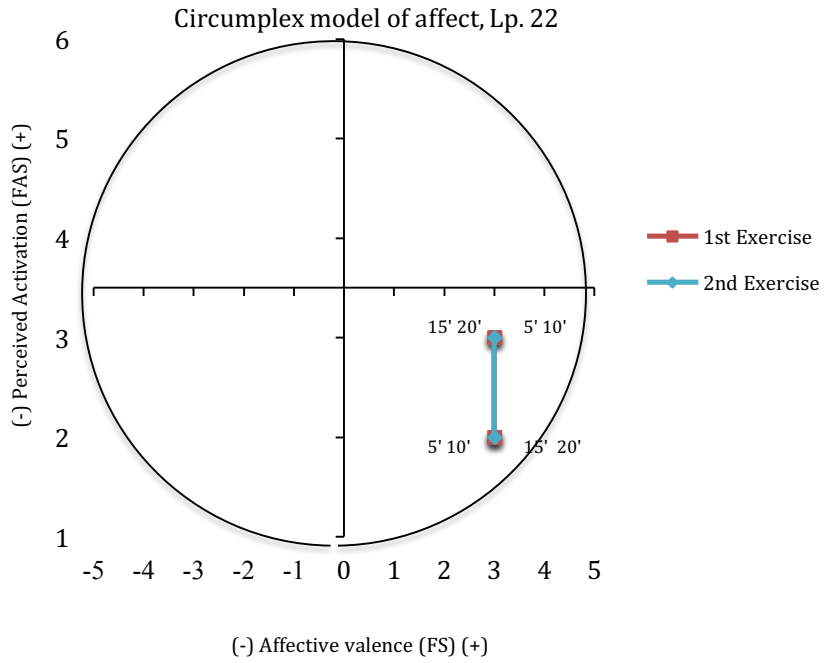


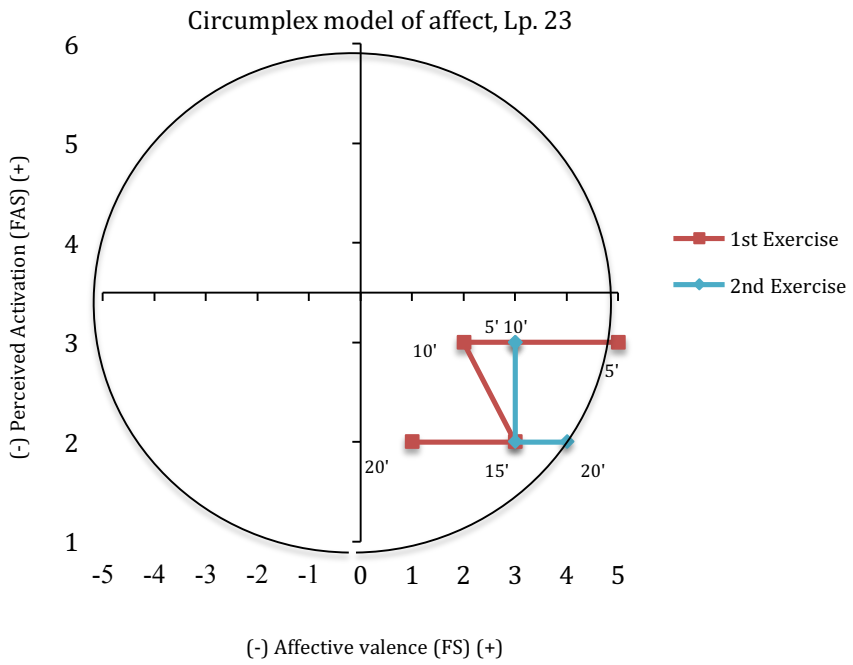
1st exercise Global affective evalaution (GAE): GAE 1' = 7, GAE 4hrs = 5, GAE 8hrs = 3, GAE 24hrs = 3.
2nd exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 6, GAE 8hrs = 5, GAE 24hrs = 2, GAE 48hrs = 4.



1st exercise Global affective evalaution (GAE): GAE 1' = 4, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 2.
2nd exercise Global affective evalaution (GAE): GAE 1' = 3, GAE 4hrs = 3, GAE 8hrs = 2, GAE 24hrs = 3, GAE 48hrs = 2.



1st exercise Global affective evalaution (GAE): GAE 1' = 3, GAE 4hrs = 3, GAE 8hrs = 3, GAE 24hrs = 2.
2nd exercise Global affective evalaution (GAE): GAE 1' = 4, GAE 4hrs = 4, GAE 8hrs = 4, GAE 24hrs = 4, GAE 48hrs = 4.



1st exercise Global affective evalaution (GAE): GAE 1' = 9, GAE 4hrs = 8, GAE 8hrs = 8, GAE 24hrs = 9.
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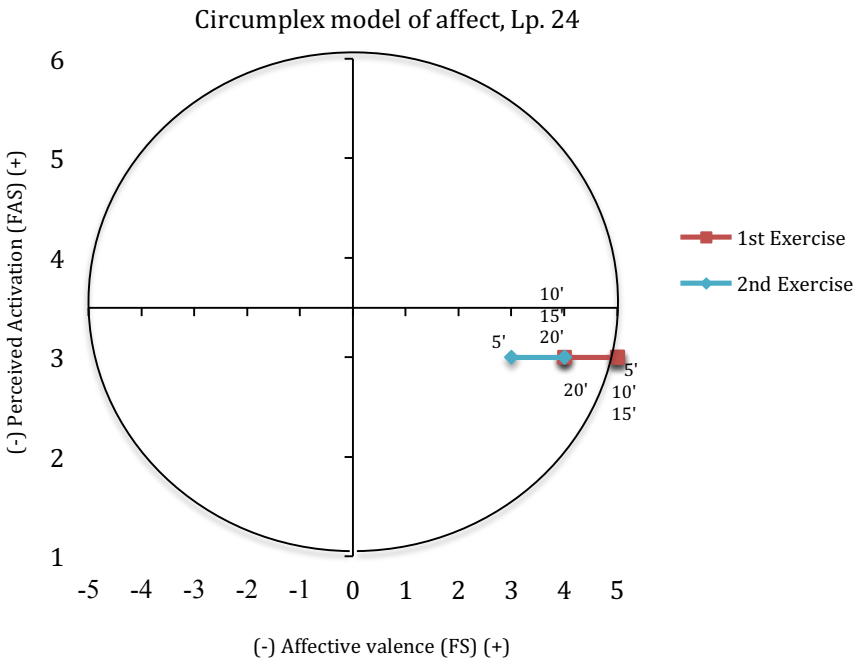
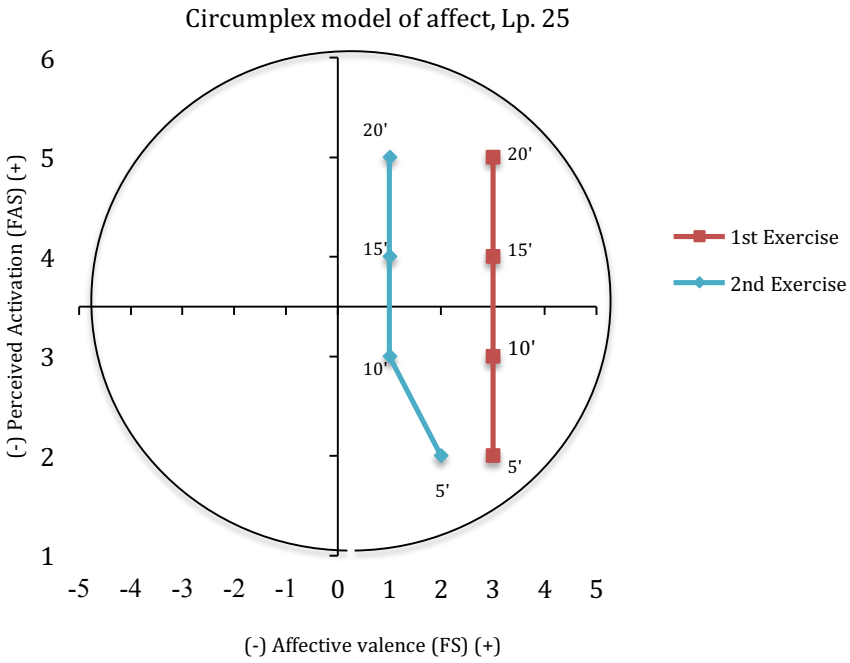


1st exercise Global affective evalaution (GAE): GAE 1' = 8, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9.
2nd exercise Global affective evalaution (GAE): GAE 1' = 9, GAE 4hrs = 9, GAE 8hrs = 9, GAE 24hrs = 9, GAE 48hrs = 9.



1st exercise Global affective evalaution (GAE): GAE 1' = 3, GAE 4hrs = 3, GAE 8hrs = 3, GAE 24hrs = 3.
2nd exercise Global affective evalaution (GAE): GAE 1' = 2, GAE 4hrs = 2, GAE 8hrs = 2, GAE 24hrs = 2, GAE 48hrs = 2.

Figure 1.15. Idiographic analysis of individual' responses plotted on Circumplex space.

Idiographic analysis

Idiographic analysis aimed at investigating individual differences in responses during the exercise (FS) were undertaken; specifically, individuals' potential shifts in the affective circumplex space during exercise, and whether recall of affective experience of exercise was associated with the shifts in the affective space were the focus of analysis. Recall responses were clustered into two groups depending on whether individuals' recall of the exercise experience was unpleasant (registered as "-1" and lower, on "-10" to "+10" scale) or pleasant (registered as "0" and higher, on "-10" to "+10" scale), during any of the recall measurement points. Overall, idiographic analysis identified a great deal of individual variability in responses during exercise (FS) and a variability in how exercise was recalled over time. Regarding the shifts in circumplex space, all of the participants during both exercise trials remained in the positive affective space. To analyse the magnitude of change, individuals' responses were compared from a start point (FS at 5min) to the last measurement during exercise (FS at 20min). The analysis revealed that in the first trial, the magnitude of change was on average, $M = 1.5, SD = .89,$ whereas in the second exercise trial it reached an average of $M = 1.53, SD = .87$. Analysis also showed that in the first exercise trial there were 36% (n = 9) of individuals who did not move on affective space (or returned to the same affective state), 32% (n = 8) declined in their affect and 32% (n = 8) of individuals improved their affect in the course of the exercise trial. In the second exercise trial, the number of individuals who did not move on the affective space (or returned to the same affective state) was 28% (n = 7), individuals who experienced improvement in their affect constituted 48% (n = 12) of total sample, and there were 28% of those who decline in their affect from the start to the end of exercise. Importantly, analyses which compared within subject changes showed that from all participating individuals 16% (n = 4) improved their affect in comparison to the

first exercise trial, 52% (n = 13) recorded no change (experienced either the same affective states or the same magnitude of a change), and 32% (n = 8) experienced improvement in their affective states in comparison to the previous exercise trial. Further, when the recall of exercise experience (GAE) was analysed together with the data from the affect measured during the exercise (FS) it was revealed that recall was positive in valence, except from two cases after the first exercise trial (Lp. 7, Lp. 14) and one case after the second exercise trial (Lp. 15).

State Anxiety and Perceived Stress

Results from repeated measures Anova on state anxiety showed no time effect on STAI measure across the four measurement points $F(3,14) = 1.79, p = .16$. However, when test of within-subject contrast was examined there was a significant difference in scores between baseline measure and the measurement immediately before the first exercise trial $F(3,14) = 5.57, p < .05, \eta^2 = .28$.

In order to examine interactions between Anticipatory feelings and PSS and GAE measures and PSS, the PSS measure has been split into two groups, low and high groups based on a median value ($M_{dn} = 12$). Those individuals who had their scores equalled the median value were excluded from further analysis. Results showed no interaction between either Anticipatory feelings and PSS ($F(3,18) = 1.52, p = .22$ nor between GAE from the first exercise and PSS ($F(3,18) = .102, p = .96$ and GAE from the second exercise and PSS ($F(3,18) = .075, p = .99$. The test of within subject contrast however showed that there was a significant interaction between anticipatory feelings and perceived stress in measurement immediately before the first exercise ($F(1,18) = 4.70, p < .05$) with a trend showing that individuals who perceive themselves as experiencing more stress anticipating the subsequent exercise as less pleasant than less stressed participants.

Results from repeated measures Anova on changes in levels of alpha amylase enzyme within individuals over time revealed a perceptible increase in enzyme concentration prior to the first exercise bout, however no statistically significant differences were found over time across the conditions ($F(3,24) = 6.12$, $p = .61$. Figure 1.16 illustrates alpha amylase results.

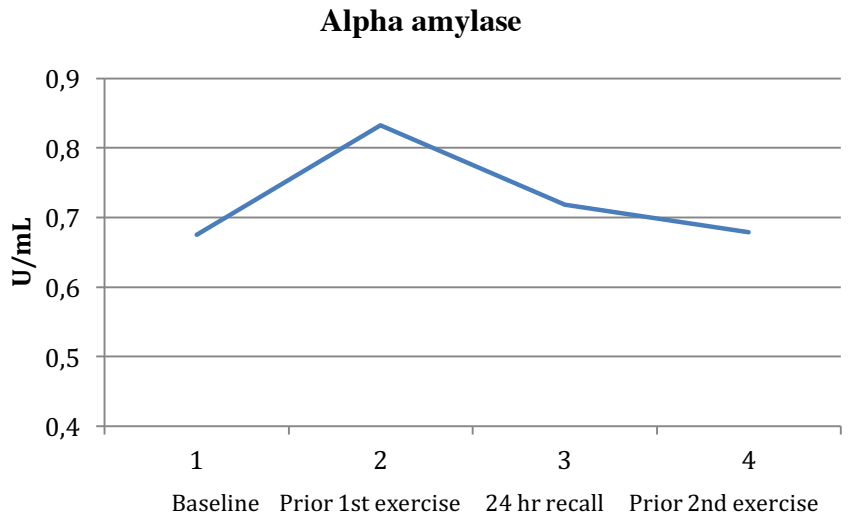


Figure 1.16 Changes in alpha amylase enzyme across the four measurement points.

6.4 Discussion

The aim of this study was to examine how individuals anticipate exercise and how they recall their affective experience from exercise when they are required to exercise at a self-selected pace on two separate occasions. Further, in the present study we aimed to investigate whether perceived and experienced stress could explain fluctuations in recall and anticipatory feelings over time. Specifically, we explored whether perceived and/or experienced level of stress could partially explain the decline in affective evaluation post-exercise which has been suggested in previous studies (e.g., Steptoe, Kimbell, & Basford, 1998).

The findings of the present study support previous results demonstrating that the recall of exercise related affect changes over time, and that there is a decline in recalled affective valence at 24 hrs post-exercise. Further, this study found that the decline commenced at 8 hrs post-exercise which retained at a similar level to the 24 hr recall measurement point. These results partially support the previous study's findings which showed a decline in recall of affective experiences from low-to-moderate and vigorous exercise at 24 hrs. However, contrary to the previous study participants exercised at a self-selected pace as a self-selected exercise intensity in the present study; this has been shown to contribute to a more positive evaluation of exercise and higher positive affective responses (Williams, 2008).

Additionally, the findings from the present study lend support to previous research suggesting that the recall of affective experience fluctuates over time and that once exercise is completed the affective recall declines regardless of the exercise intensity. A further development in terms of the research protocol used in the previous study included the completion of two exercise trials scheduled within 48 hrs. This protocol was designed to assess whether the 24 hr decline in recall of affective responses would endure when individuals have another scheduled bout of exercise. This study found support for this conjecture, thus reinforcing the findings whilst simultaneously increasing the study's ecological validity.

Idiographic analysis showed that in general terms, exercise was perceived as being pleasant by all of the participants and the magnitude of change was modest during both of the exercise trials. Recall of affective experience was also recorded as pleasant by all but three cases. These results are in line with research proposing that when individuals select their own exercise pace, they are more likely to experience more pleasant affect than those for whom exercise intensity is pre-determined (Ekkekakis, 2009; Vazou-

Ekkekakis & Ekkekakis 2009). The analysis also revealed that exercisers improved their affective states when asked to exercise for the second time. These results may be influenced by a sense of familiarity with the test conditions; specifically when asked to exercise again under the same conditions (i.e., self selected pace) the task may have been evaluated more favourably as uncertainty regarding the laboratory setting and task demands were reduced.

In consideration of the theoretical implications of the present study, the dissonance between experienced and recalled emotional events has been explained in the research literature by the construal level theory which suggests that temporal remoteness causes the representation of an event to be characterized by a few abstract elements; whereas temporal proximity leads to representation by multiple-incidental details (Trope & Liberman, 2003). The increasing distance (i.e., time) from the terminated exercise may have decreased the elements from the actual experience that individuals recorded, thus resulting in the altered affective judgment of the exercise experience. Whilst previous studies have documented the discord between experience and recall in the exercise setting, they also highlight that moments of intensified experience (i.e., peaks) and how the exercise terminates (i.e., ends) may be good predictors of how individuals remember their activity (Hargreaves & Stych, 2012); the present study illustrates that such recollection oscillates over time. Therefore, future research should compare the effects revealed in peak and end studies on global affective evaluation by examining the recall in different points of time. It may also be of interest for prospective studies to examine whether different points of recall could be predicted from particular stages of exercise (i.e., peaks).

As indicated in the research literature, long-term goals are more difficult to achieve; thus, the anticipation of the immediate affective benefits derived from exercise

may be a more salient factor influencing individuals' decisions to be physically active (Baumeister et al., 2007; Fredrickson, 2010; Helfer, et al., 2015). In the present study we demonstrated that anticipatory feelings to exercise were less favourable before the first exercise when compared to the second exercise trial performed 48hrs later. Based on previous findings these results may imply that when a task is novel and individuals are not familiar with the demands they may overestimate the effort they need to put towards the activity or overestimate the expected pain that will ensue from the activity; as a consequence less positive prediction of affective experience during the task may be reported (Rachman & Arentz, 1998).

The novelty and uncertainty of undertaking a new exercise task may also trigger increased levels of stress which was evident when examining the interaction between anticipatory feelings and state anxiety. Despite the overall non-significant differences in state anxiety across the four measurement points recorded at the four visits to the laboratory, the difference between the baseline and first exercise trial reached a level of statistical significance indicating an elevated level of state anxiety related to anticipatory affective evaluation of the first exercise trial. Furthermore, individuals reporting greater life stress, as measured by the PSS, anticipated the affective experience of the upcoming exercise less positively than individuals who perceived their lives as being less stressful. Therefore, it is possible that those who are more sensitive to stressful situations, and experience high levels of stress may appraise upcoming exercise as being less pleasant due to terminated anxiolytic effect from exercise. These results are marginally supported by biological measures obtained in the study which indicate a trend in the data that shows an increase in alpha amylase enzyme before the first exercise trial. These results however were not significant and require further scrutiny. Importantly, previous research findings imply that increases in alpha amylase as a result of physical and psychological stress are

detectable in relation to high intensity exercise but not exercise at a low to moderate intensity (Koibuchi & Suzuki, 2014); lower levels of exercise intensity were most likely selected by participants in the present study.

The present study has a number of limitations that could be eschewed by improving the research design and protocol used. Specifically, the study design could be improved by examining participants' real physical fitness with an objective measure such as a VO2max test in order to establish ventilation threshold and use this information for monitoring exercise intensity which was shown to directly impact exercise related affect. The exercise behaviour measured in this study provided important information on a range of activities which participants usually engage in, however the objective measure of physical fitness may contribute more to the understanding of whether the evaluative processes are the same among more or less fit individuals. In this study, we surmise that the termination of anxiolytic effect demonstrated in the previous studies may be explained by increases in perceived and experienced levels of stress. However, the design of the study does not permit a causal relationship to be identified between the termination of anxiolytic effect and increased levels of anxiety. The link between perceived stress, appraisal of a stressful situation, and anxiolytic effect should be examined in more detail in future studies.

Whilst the idiographic analysis shows robust individual variability and points to potential underlying mechanisms that could not be deciphered in aggregated analyses, it is important to note also its limitations. Firstly, as the change in affective valence was assessed only using the first and last measurement point, the analysis could not account for any individuals who shifted in the affective space but returned to the same affect state reported before completing the exercise. Moreover, because of the grouping of recall responses (GAE) into positive (from "10" to "0") and negative (from "-1" to "-10"), not

all changes were accounted for. Correspondingly, the magnitude of change nor the frequency of recall could be accounted for, this prohibits a comprehensive understanding of the full dynamics of the relationship between experienced affect and its recall.

Moreover, as previous studies identified changes in biological measures such as alpha amylase enzyme associated with stress in high intensity exercise, the research protocol used in future studies should differentiate between low and high intensity exercise. In relation to this, based on individuals' perceptions of intensity and associated effort required for completion of exercise trials, future studies may consider the mechanisms of recall and anticipatory feelings on sedentary populations in comparison with those who exercise regularly.

In conclusion, the present study raises important applied implications for professionals aiming to optimise health and wellness through physical activity. Training programmes designed to improve exercise adherence and optimise the exercise experience should consider the temporal fluctuations in recall of exercise related affect especially during the first 8 to 24 hours post-cessation of exercise, when the decline is the strongest. Likewise, as results of this study indicate anticipation of exercise may be constrained when undertaking a new exercise task, especially among those who perceive high levels of stress, fitness professionals and health practitioners should consider the emotional profiles of individuals when prescribing "exercise as medicine".

7. General discussion

7.1 General discussion

The central aim of this thesis was to gain a better understanding of factors that impact the evaluation of affective experiences associated with exercise. In order to accomplish this aim the external and internal factors highlighted in the research literature as being influential in individuals' evaluations of their affective responses to exercise were examined.

The experience of exercise has been highlighted as a relevant construct to study person-environment interactions as it reflects a person's attitude towards different aspects of the environment and the associated meaning of the environment for the person (Vygotsky, 1982). Further, *experience* has a biosocial orientation as each interpretation of an experience is informed by the individual's previous experience of related events and, as such, is best represented as a unit of consciousness. Thus, it is recommended that the analysis of any demanding situation should focus exclusively on the characteristics of situation or on the person per se, but rather how the situation is experienced by *this* person. This approach has been adopted in the thesis because the principal aim was to develop a comprehensive understanding of the experience of exercise phenomena. The following sections of the discussion: outline the overall findings of the program of research; offer possible explanations of the results; identifies limitations; highlights implications; and proposes future research directions. Finally, a summary conclusion of the research undertaken is provided.

Physical inactivity is a contributing factor for many severe health problems including immature deaths (Haskell et al., 2007). The serious implications of physical inactivity have garnered global attention and spurred efforts to develop public health recommendations gained from research findings (Ekkekakis, 2011). Nonetheless, insufficient physical activity remains an issue with two thirds of adults not reaching

recommended levels of physical activity (Lee et al., 2012). Research has revealed many factors that promote sustained physical activity as well as factors that contribute to non-adherence (Netz, Zeev, Arnon, & Tenenbaum, 2008; Biddle & Fuchs, 2009). Empirical research has also shown that affective responses to exercise play a crucial role in how one experiences exercise (e.g., Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007) and whether one will maintain exercise participation (Ekkekakis 2003; Kwan & Bryan, 2010; Williams et al., 2008).

Further, one factor that particularly impacts upon the perceived pleasantness of exercise is intensity (e.g., Ekkakakis, 2009; Ekkekakis & Petruzzello, 1999; 2002). Studies indicate that as exercise intensity increases, engagement in physical activity begins to generate exertive sensations that eventually reach a level of discomfort at which further participation is uncomfortable or even intolerable (Ekkekakis, Hall, & Petruzzello, 2005). The dual mode model (DDM; Ekekakkis, 2003) accounts for this phenomenon by identifying a shift that occurs at the level of one's Ventilation threshold (VT). The model proposes that under light to moderate intensities, affective responses are mostly pleasant and are generated by cognitive appraisal; whereas when the exercise intensity rises beyond the point of VT, affective responses begin to decline and are resourced by the domination of interoceptive cues. Studies also indicate that when individuals are asked to self-select the intensity of exercise which they prefer, the affective responses are improved when compared to prescribed intensity exercise (Vazou-Ekkakakis & Ekkekakis, 2009; Williams, 2008).

In consideration of the aforementioned DDM model and previous research studies, the purpose of this thesis was to advance knowledge of affective experiences in exercise by further examining the external and internal factors that contribute affective responses to exercise. In summary, the findings from the thesis suggest that both external

and internal factors play an important role in the evaluation of affective responses to exercise. Study one showed that within person factors such as motivation for exercise intercede with the perception of the environmental cues. Previous literature strongly suggests that the environment in which one exercises can alter affective responses to the experience (DaSilva, et al., 2011; Focht, 2009). Specifically, the results revealed that during exercise individuals utilize cues from the environment which in turn tend to alter the evaluation of affective experience from exercise. Notably, the results from these studies (e.g., Focht, 2009) were obtained by comparing exercise in a laboratory to exercise in the outdoors. The first study of this thesis aimed to explore the influence of environment by examining individuals exercising in their natural exercise setting (i.e., gym that they were members of) and investigating whether affective evaluations would be sensitive to environmental cues in their natural and familiar exercise environment. The study's results suggest that when individuals' principal motives for exercise are matched with the content of the environmental cues, the evaluation of affect as well as motivation is improved. However, when the cues were not congruent with one's principal motives for exercise the evaluation is inhibited, resulting in a less favourable evaluation of affective and motivation responses to exercise. Further, participants were asked to exercise on a treadmill at a self-selected exercise intensity with the aim of optimising their feeling states (Vazou-Ekkekakis & Ekkekakis 2009). Results of the study also revealed that perception of effort remained unchanged throughout the study's conditions which could be reasoned in that individuals' evaluation of perceived effort was grounded on physical sensations rather than cognitive appraisals which could be influenced by environmental cues. Thus, considering that individuals were asked to exercise at the same pace across the two conditions, it is possible that physically detectable cues from exercise aided evaluation resulting in analogous responses across two exercise trials. Collectively,

the results from this study lend support to the assumption that motivational, contextual cues positively affect only those who perceive the messages as being goal related content. Interestingly, reported feelings of those who were primed with non-related content were inhibited when compared to a control condition. These results strongly emphasise the importance of carefully selecting features of the exercise environment. Specifically, the study results contribute to knowledge regarding factors which influence affective and perceptual responses to exercise, showing that not only environmental cues are important but also how they interact with the motives one has for exercising.

It is important to note that the initial aim of this study was to examine the impact of both appearance motive related cues and health motive related cues as previous research suggests that individuals principally exercise for these two motives (Ingledew & Markland, 2008; Vartanian, Wharton, & Green, 2012). During the validation process of the cues however, the health related cues could not be selected because there was insufficient consistency in responses revealing that individuals perceive health related cues very differently. These findings underline the complexity of individuals' perceptions and vastly distinctive approaches that individuals take when appraising health aspects from exercise. The evident importance of internal factors in exercise behaviour, and in particular the evaluation of affective responses, has guided the research of the remaining two studies of this thesis.

The role and interplay of affect and cognition have been investigated for many years, with some researchers arguing that affective reactions are precognitive, and requiring no conscious appraisal (Zajac, 1980), some postulating that affect is the outcome of appraisal processes that are necessarily cognitive (Lazarus, 1982), and others suggesting that affect is assimilated into an associative network model of memory (Anderson & Bower, 1973; Bower, 1981). The debate has not been completely resolved,

although it has led to a common postulation that humans ground their conceptual thinking perceptually, and perceptions are important antecedents of subsequent cognitions and emotions (Barsalou, 2010). Following this conjecture, it could be implied that the outcome of perception i.e., a prompt that caught an attention is likely to drive responses and thus how people feel; for example, exercising is likely to be affected by perception and salient cues from the environment. This assumption is analogous with the DMM, as exercise at low and moderate intensities are undertaken when the cognitive appraisal is responsible for generating the affective responses to a physical task. Studies from behavioural psychology also found support for these findings, outlining that relative evaluation can ensue within an individual by involuntary attention which is affected by aspects of the environment that are novel, unexpected, affect–related or simply salient (Kahneman, 1973).

Moreover, research on affective responses fairly consistently demonstrate that individuals report pleasant feelings from exercise; in particular, pre to post exercise reports are largely positive with elevated pleasant feelings after the exercise is completed. The positive feelings in turn are shown in the literature to direct behaviour towards an activity which is in contrast to the data on global inactivity. The paradox was further investigated by Backhouse et al., (2007) who showed that affective responses which individuals experience change considerably over time and individuals experience both, positive and negative affect. While the experience of exercise has been shown to be critical for how one perceives exercise, it is also suggested that the memory of affective experience may differ to the actual experience and the recall as well as the anticipatory feelings should be included in the analysis when attempting to better understand the affect-adherence relationship (Ekkekakis, Hall, & Petruzzello, 2013; Williams, 2008).

The second and third study of this thesis examined these processes by exploring the recall of affective experience and anticipatory feelings to exercise. In study two, participants were asked to perform two bouts of exercise with low-to-moderate and high intensity, after which for the following 14 days they were asked to record their global affective evaluation (i.e., how they remembered pleasantness from performed exercise). The study's results show that recall of affective experience fluctuates over time. The results also reveal that at 24 hrs post-exercise there is a considerable decline in affective evaluation from completed exercise. The decline was repeatedly observed at two exercise intensities, low-to-moderate and high intensity, with high intensity being evaluated less favourably across all the measurement points. Further, the study also highlights that anticipatory feelings measured immediately preceding the exercise are more accurately predicted by the recall measures than the measurement of affect during the previous exercise.

The findings from study two show support for the Dual Mode model, revealing that high intensity exercise is experienced less positively than low-to-moderate intensity. This study contributes to the research on the affect-exercise intensity relationship by outlining how exercise intensity influences post exercise affective evaluation (i.e., global affective evaluation). The results of study two are also in line with a framework on the *Peak and End* rule (Hargreaves & Stych, 2013; Miron-Shatz, Stone, & Kahneman, 2009) which implies that there are two separate processes; one when the actual experience occurs, and another associated with how it is recalled over time. Specifically, it was proposed that individuals tend to remember the greatest intensity of an experience and how it finishes, instead of an average of the whole experience. For example, if individuals go through an exercise session and experience periods of intense negative affect regardless of generally feeling moderately good across the majority of training - this

intense negative affect may cause the recall of the experience to be negative. This proposed explanation may also relate to the previous research which highlights that people who exercise at a high intensity have significantly lower levels of adherence than those who exercise with a moderate intensity (DaSilva et al, 2011; Sallis, et al., 1986). The second study examined the prepositions of the *peak and end* rule (Brewer, Manos, McDevitt, Cornelius, & Van Raalte, 2000; Hargreaves & Stych, 2013). When analysing individuals' responses from the study's two conditions, the data indicated no clear peaks thus the factor of a *peak* was disregarded from further analysis. In regards to the *end* factor, due to an uneven number of participants reporting a change in affect in the low-to-moderate condition group only the high intensity exercise condition was considered. The findings showed support for the previous studies indicating that when individuals finish high intensity exercise on a negative valence (unpleasant feeling state) their recall is more negative than those who finish exercise with a more favourable feeling state. In light of contemporary research and acknowledgment of the importance of the affective responses to exercise, the study's results make an important contribution as they highlight how the memory of pleasantness is affected by time passing. The study's results also highlight the importance of exercise intensity and provide support to previous studies (e.g., Ekkekakis, 2013); also they extend knowledge of how exercise intensity impacts upon individuals' recollection of the affective experience of exercise.

Study three followed on from the protocol of study two with two alterations; firstly, individuals were asked to exercise at a self-paced intensity exercise, secondly they were asked to complete two exercise trials within 48 hrs. The aim of this protocol was to optimise affective responses by giving individuals autonomy to choose their exercise pace, and secondly since the changes in post exercise were suggested to be in relation to psycho-physiological factors, the aim was to examine whether structured exercise that is

planned would alter the recall of affective experience. Results of study three partially confirmed the results from study two, showing that upon the termination of exercise recall of the affective experience fluctuated over time with a significant reduction in the recall of affective experience at 8 and 24 hrs post-exercise. The results also indicate on the impact of psychological stress in anticipation of the first exercise trial but not the second trial. Although the findings have not reached traditional level of significance they imply that individuals with higher perceptions of stress may perceive an upcoming, novel experience of exercise more negatively. These preposition however need further investigation.

A potential explanation for the decline in affect observed in studies two and three (and potential future research direction) may relate to individuals' experience of post exercise soreness in muscle. Post exercise muscle soreness has been explained in the literature within a framework of delayed onset muscle soreness (DOMS; ACMS, 2014; Kenney, Wilmore, & Costill, 2012). However, the phenomenon is still not fully explained due to the occurrence of indirect, delayed processes which are not yet fully understood (Kenney et al., 2012). Nonetheless, current research suggest that DOMS is a type 1 muscle strain, varying from light muscle stiffness to severe pain that may restrict movement (Gulick & Kimura, 1996). Follow up studies further examining the occurrence of DOMS show that the soreness developed 24 hours to 48 hours post exercise is not related to blood lactate concentration, despite this being previously forwarded as the reason for the experienced pain (Gulick & Kimura, 1996; Kenney et al., 2012). It is important to note that the two studies conducted in this thesis have not directly examined the impact of DOMS in post exercise evaluation; thus it cannot be determined if the decline in global affective evaluation is related to DOMS. Further research is strongly encouraged to undertake this line of research; specific examination of the relationship

between muscle soreness and affective responses is warranted as it may be an important factor for exercise adherence.

Another contribution of the studies conducted in this thesis is in regards to the idiographic analyses which complement aggregate-based analyses. Previous research indicates individuals report both increased and decreased pleasure from exercise as well as increased displeasure (Ekkekakis, 2013). The response variability strongly indicates the necessity to account for individuals' changes by scrutinizing data at the individual level. In this thesis, the studies' aggregated level analyses were supplemented with individual-based analysis of changes in affective responses. In the first study feeling states, motivation and perceived effort were plotted under two exercise conditions, showing great variability of how individuals respond to the task and experimental manipulation. The results of the second and third studies were plotted on a circumplex space with affective valence and perceived arousal for each individual across the two exercise trials. This method was used to account for all individuals' changes that occurred during the exercise, simultaneously illustrating the great variability across individuals. Data gained from Circumplex graphs were analysed by grouping individuals into clusters in accordance whether and how they have moved in the affective space. Results clearly indicated on a great variability between individual responses. Importantly, analyses showed that unpleasant affect experienced during the high intensity exercise is likely to be a factor that makes the recall of terminated exercise experience unpleasant and that such recall is likely to prolong over the course of time. This is important in light of research that revealed the inhibiting effects of unpleasant recall on future behavioural choices (Kahneman, 2000). Whilst it is important to look for factors that can explain changes in affective responses to exercise, it is also crucial to account for individual differences that within the affect-exercise relationship are pronounced. The three studies

comprising this thesis demonstrate support for this approach by outlining individuals' unique affective experiences pre, during, and post exercise.

7.2 Limitations and future directions

Whilst the studies presented in this thesis enhance knowledge in the area of affect and exercise research, it is important to recognise their limitations.

During the completion of the first study a number of limitations arose. The aim of the first study was to compare the influence of environmental cues on the evaluation of affective and motivational responses to exercise by comparing the two conditions (i.e., experimental and control). The study's results however, would have been more informative if the measurement of affect was collected before and during the activity as it would have been possible to detect when exactly the change occurs. The first study reported in this thesis demonstrates that exercisers' affective and cognitive evaluation of an exercise experience is influenced by contextual cues and that their motives for exercise play an important role in how these cues are utilised. The study implies that when motives are congruent with the content of cues, the affective and motivational evaluation is improved; whereas when the motives for exercise do not align with the messages conveyed in the cues, the presentation of the cues inhibit affective and motivational evaluation when compared to a control condition. Furthermore, within the study only one motive was examined (i.e., appearance motive); it would be informative to investigate how individuals with other motives respond to exercise under the two conditions and whether different cues also trigger diverse evaluation.

In study two of this thesis, the recall of affective responses was examined together with anticipatory feelings to exercise. A clear limitation of this study was that during the two-week recall period, neither meaningful life events nor an actual level of physical

activity were controlled for which could have an impact upon the recollection of the previous affective experience of the exercise activity. Although participants were strongly advised that they should refrain from physical activity, it cannot be presumed with certainty that they adhered to the advice. Furthermore, the potential explanations that were offered to account for the decline in recall of affective experience (i.e., the termination of anxiolytic effect of exercise and DOMS) are only hypothetical; individuals who took part in the study were not specifically examined for these potential mechanisms. Henceforth, future studies should undertake the examination of these proposed explanations and assess whether individuals actually experience a termination of anxiolytic effect or a delayed onset muscle soreness during post-exercise evaluation.

Further, one important limitation of study three relate to the design of the study and in particular the lack of a VO2max measurement which would have allowed for the examination of participants' physical fitness and relative exercise intensity during the self-paced exercise protocol. The exercise behaviour measure (i.e., LTEQ) used in this study provided important information on a range of activities which participants usually engage in; however an objective measure of physical fitness may have contributed more to the development of knowledge if the evaluative processes examined were compared between individuals of varying physical fitness.

Furthermore, the design of the study also does not allow for inferences to be made on a causal relationship between the termination of anxiolytic effect and increased levels of anxiety. Therefore, the links between perceived stress, appraisal of the potentially stressful situation, and the anxiolytic effect should be examined in more detail in future studies. Moreover, as psychophysiological stress indices highlight changes in the biological measures (e.g., alpha amylase enzyme), future study protocols should differentiate between low and high intensity exercise. This aspect should be considered

in prospective studies in an attempt to examine post exercise affect in concordance with psychophysiological aspects.

Based on the findings from study one and two it is important for prospective studies to further examine *when* exactly people make decisions to engage in exercise in order to understand how exercise induced affect that is recalled over time interacts with evaluative processes and as a consequence how it is integrated into decision-making guiding future exercise behaviour. Similarly, future studies may consider using a qualitative approach and more in depth enquiry to further examine recalled affective experience from exercise with a particular focus upon the 24 hour post-exercise time point. Prospective studies may also examine if the 24 hour post-exercise drop in the recall of affective experience persists if individuals are participating in a longer program of exercise and have scheduled another exercise session within the following days.

Moreover, it has been pointed out that one considerable shortcoming that has prevented exercise research from further development relates to the appropriateness of measurement and limited use of diverse approaches to examine affect (Winkelman, et al., 2007). Generally, there are two main trends in the research on affect which take opposite standpoints (i.e., whether or not affect depends on cognition). As a result of this debate, there are two predominant methodologies which have produced research on affective phenomenon; one looking at affective responses as a core or basic affect which involve dimensions of valence and arousal (Russell, 1980; 2003), and another line of research which views affective responses by incorporating appraisal of affect as an integral part, and tend to operate affect as discrete states and emotions (Clore, 1994; Schrer, Schorr, & Johnston, 2001). As Russell (2003) and Ekkekakis (2013) suggest, when examining affective responses to exercise the dimensional perspective is more appropriate as it is capable of capturing more changes in feeling states than discrete emotions which may not

be perceptible by some individuals. Nonetheless, it was suggested that when one is looking for changes in a specific construct, discrete emotions are a better construct to use. In this thesis the dimensional perspective was adopted to capture changes in affective responses to exercise and to measure current feelings state. In the future, research should consider including some measures of specific emotions such as fear, fatigue and tranquillity, as results indicate that post-exercise changes point out possible interactions between psychological and physiological states that could be captured in more depth by the aforementioned constructs. Specifically, it is likely that discrete emotions could help to examine whether individuals in the post-exercise phase experience termination of anxiolytic effect or whether they feel pain and fatigue from their muscles.

7.3 Conclusion

The studies comprising this thesis highlight the importance of external and internal factors that impact upon the affective evaluation of exercise, and that the memory of exercise induced affect depends on the timing of the recall. Further, the studies in this thesis examined these factors by employing advanced methodological approaches (i.e., ecological momentary measurement including sampling together with physiological measures), which provided insight into new findings and offered considerations for future research. More specifically, future research should aim to develop methods for examining when (and how) individuals make decisions regarding exercise participation and what psychophysiological processes occur in the post exercise period, in particular in the 48 hours following completion of exercise. Based upon these potential findings arising from future research, it may be possible to improve the effectiveness of exercise interventions in ecologically valid settings.

The findings arising from this program of research offer new information regarding the affect-exercise relationship, and carry important applied implications; however, the limitations underlying the research designs should also be considered. Future research may advance this line of inquiry by further investigating factors that influence how one evaluates their affective experience during and after the exercise is completed through methods that extend those used in this program of study. The impact of this research will hopefully make a meaningful contribution towards addressing the physical inactivity crisis, and potentially enhance general health and wellbeing.

8. References

American College of Sports Medicine (2009). *ACSM's guidelines for exercise testing and prescription* (8th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

American College of Sports Medicine (2014). *ACSM's guidelines of exercise testing and prescription* (9th ed.). Philadelphia: Lippincott Williams & Williams.

Annesi, J. J. (2005). Relationship between before-to-after-exercise feeling state changes and exercise session attendance over 14 weeks: testing principles of operant conditioning. *European Journal of Sport Science, 5,* 159–163.

Antoniewicz, F., & Brand, R. (2014). Automatic evaluations and exercise setting preference in frequent exercisers. *Journal of Sport and Exercise Psychology, 36,* 631-636. Doi: 10.1123/jsep.2014-0033.

Ariely, D., Huber, J., & Wertenbroch, K. (2005). When do Losses Loom Larger than Gains? *Journal of Marketing Research. 42, 134-138.*

Arntz A. (1996). Why do people tend to overpredict pain? On the asymmetries between under predictions and over predictions of pain. *Behaviour Research and Therapy, 34,* 545–54.

Backhouse, S. H., Ekkekakis, P., Biddle, S. J. H., Foskett, A., & Williams, C. (2007). Exercise makes people feel better but people are inactive: Paradox or artifact? *Journal of Sport and Exercise Psychology, 29,* 498-517.

Bagozzi, R. P., & Pieters, R. (1998). Goal-directed emotions. *Cognition and Emotion, 12,* 1-26. DOI:10.1080/026999398379754

Bateson, M., Nettle, D., & Roberts, G. (2006). Cues of being watched enhance cooperation in a real-world setting. *Biology Letters, 2,* 412-414.

Baumeister, R. F., Vohs, K. D., DeWall, C. N., & Zhang, L. (2007). How emotion shapes behavior: Feedback, anticipation, and reflection, rather than direct causation.

Personality and Social Psychology Review, 11, 167-203.

Beaver, W. L., Wasserman, K., & Whipp, B. J. (1986). A new method for detecting anaerobic threshold by gas exchange. *Journal of Applied Physiology, 60,* 2020–2027.

Bentham, J. (1824/1987). *An introduction to the principles of morals and legislation*. In J. S. Mill and J. Bentham, Utilitarianism and Other Essays, Harmandsworth: Penguin.

Berger, B. G., & Owen, D. R. (1992). Mood alteration with yoga and swimming: Aerobic exercise may not be necessary. *Perceptual and Motor Skills, 75,* 1331–1343.

Biddle, S. J. H., & Fuchs, R. (2009). Exercise psychology: A review from Europe. *Sport and Exercise Psychology, 10,* 410-419. Doi: 10.1016/j.psychsport.2009.02.011.

Black, T. L. (2008). Exercise and fitness in a U.S. commercial gym. (Unpublished doctoral dissertation). University of California. United States.

Blanchfield, A., Hardy, J., & Marcora, S. (2014). Non-conscious visual cues related to affect and action alter perception of effort and endurance performance. *Frontiers in Human Performance, 8,* 1-16. Doi: 10.3389/fnhum.2014.00967.

Borg, G. (1982). Ratings of perceived exertion and heart rates during short-term cycle exercise and their use in a new cycling strength test. *International Journal of Sport Medicine, 3,* 153-158.

Borg, G. A. V. (1998). *Borg's perceived exertion and pain scales*. Champaign, IL: Human Kinetics.

Brewer, B. W., Manos, T. M., McDevitt, A. V., Cornelius, A. E., & Van Raalte, J. L. (2000). The effects of adding lower intensity work on perceived aversivess of exercise. *Journal of Sport and Exercise Psychology, 22,* 119-130.

Broocks, A., Bandelow, B., Pekrun, G., George, A., Meyer, T., Bartmann, U., … Ruther, E. (1998). Comparison of aerobic exercise, clomipramine, and placebo in the treatment of panic disorder. *American Journal of Psychiatry, 155,* 603-609.

Bryan, A., Hutchison, K. E., Seals, D. R., & Allen, D. L. (2007). A transdisciplinary model integrating genetic, physiological and psychological correlates of voluntary exercise. *Health Psychology, 26,* 30-39.

Calitri, R., Lowe, R., Eves, F. F., & Bennett, P. (2009). Associations between visual attention, implicit and explicit attitude and behaviour for physical activity. *Psychology and Health, 24,* 1105-1123. DOI: 10.1080/08870440802245306.

Carels, R. A., Berger, B. G., & Darby, L. A. (2006). Mood states in obese, sedentary, postmenopausal women: Predictors of physical activity and fitness. *Journal of Aging and Physical Activity, 14,* 12-28.

Carels, R. A., Coit, C., Young, K., & Berger, B. G. (2008). Exercise makes you feel good, but does feeling good make you exercise?: An examination of obese dieters. *Journal of Sport and Exercise Psychology, 29,* 706-722.

Carson, S. J. (2013). Effects of emotional exposure on state anxiety after acute exercise. *Medicine and Science in Sport and Exercise, 45,* 372-378.

Chatzisarantis, N. L. D., Kee, Y. H., Thaung, H. K., & Hagger, M. S. (2012). When small losses do not loom larger than small gains: Effects of contextual autonomy support and goal contents on behavioural responses to small losses and small gains. *British Journal of Social Psychology, 51,* 690-708.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155- 159.

Connolly, D. A, Sayers, S. P, & McHugh, M. P. (2003). Treatment and prevention of delayed onset muscle soreness. *Journal of Strength and Conditioning Research, 17,* 197–208.

Conroy, D. E., Hyde, A. L., Doerksen, S, E., & Ribeiro, N, F. (2010). Implicit attitudes and explicit motivation prospectively predict physical activity. *Annals of Behavioral Medicine, 39,* 112-118.

DaSilva, S. G., Guidetti, L., Buzzachera, C. F., Elsangedy, H. M., Krinski, K., De Campos, W., Goss, F. L., & Baldari, C (2011). Psychophysiological responses to self-paced treadmill and overground exercise." *Medicine and Science in Sport and Exercise, 43,* 1114-1124.

Desharnais, R., Bouillon, J., & Godin, G. (1986). Self-efficacy and outcome expectations as determinants of exercise adherence. *Psychological Reports, 59,* 1155-1159.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130,* 355-391.

Dienier, E., & Lucas, R. E. (1999). Personality and subjective well-being. In D. Kahneman, E. Diener, and N. Schwartz (Eds.), *Well-being: The foundation of hedonic psychology* (213-229). Russell Sage Foundation: New York.

Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective Well-being: three decades of progress. *Psychological Bulletin, 125,* 276–302.

Dillman, D. A. (1978). *Mail and telephone surveys: The total design method*. New York: John Wiley and Sons, Inc.

Dimmock, J. A., Chatzisarantis, N. L. D., Podlog, L., Martin, T. L., Iriye, H. M., & Jackson, B. (2015). Seek, and you will find; Influence of expectations on evaluation of physical activity. *Australian Psychologist, 50,* 173-181.

Dimmock, J. A., Jackson, B., Podlog, L., & Magaraggia, C. (2013). The effect of variety expectations on interest, enjoyment, and locus of causality in exercise. *Motivation and Emotion, 37,* 146-153.

Ebbesen, B. L., Prkachin, K. M., Mills, D. E., & Green, H. J. (1992). Effects of acute exercise on cardiovascular reactivity. *Journal of Behavioral Medicine, 15,* 489-507.

Ekkekakis P. (2003). Pleasure and displeasure from the body: Perspectives from exercise. *Cognition and Emotion, 17,* 213–239.

Ekkekakis P. (2009). Let them roam free? Physiological and psychological evidence for the potential of self-selected exercise intensity in public health. *Sports Medicine, 39, 857*–88.

Ekkekakis, P. (2012). The measurement of affect, mood, and emotion in exercise psychology. In G. Tenenbaum, R. C. Eklund, & A. Kamata (Eds.), *Measurement in sport and exercise psychology* (pp. 321-332). Champaign, IL: Human Kinetics.

Ekkekakis, P. (2013). The measurement of affect, mood, and emotion: A guide for health-behavioural research. Cambridge, UK: Cambridge University Press.

Ekkekakis, P., & Acevedo, E. O. (2006). Affective responses to acute exercise: Toward a psychobiological dose-response model. In E. O. Acevedo & P. Ekkekakis (Eds.), *Psychobiology of physical activity* (pp. 91-109). Champaign, IL: Human Kinetics.

Ekkekakis, P., Backhouse, S. H., Gray, C., & Lind, E. (2008). Walking is popular among adults but is it pleasant? A framework for clarifying the link between walking and affect as illustrated in two studies. *Psychology of Sport and Exercise, 9,* 246-264.

Ekkekakls, P., Hall, E. E., & Petruzzello, S. J. (2001). Intensity of acute exercise and affect: A critical reexamination of the dose-response relationship. *Medicine and Science in Sports and Exercise, 33,* 50.

Ekkekakis, P, Hall, E. E., & Petruzzello, S. J. (2004). Practical markers of the transition from aerobic to anaerobic metabolism during exercise: Rationale and a case for affect-based exercise prescription. *Preventive Medicine, 38,* 149-159. Doi:10.1016/j.ypmed.2003.09.038.

Ekkekakis, P, Hall, E. E., & Petruzzello, S. J. (2005). Variation and homogeneity in affective responses to physical activity of varying intensities: An alternative perspective on dose response based on evolutionary considerations. *Journal of Sports Sciences, 23,* 477-500.

Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2005). Some like it vigorous: Individual differences in the preference for and tolerance of exercise intensity. *Journal of Sport and Exercise Psychology, 27,* 350–374.

Ekkekakis, P, Hall, E. E., & Petruzzello, S. J. (2008). The relationship between exercise intensity and affective responses demystified: To crack the 40-year-old nut replace the 40-year-old cracker. *Annals of Behavioral Medicine, 35,* 136-149. Doi: 10.1007/s12160-008-9025-z.

Ekkekakis P., Hargreaves E. A, Parfitt G. (2013). Envisioning the next fifty years of research on the exercise–affect relationship. *Psychology of Sport and Exercise, 14,* 751-758.

Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011). The pleasure and displeasure people feel when they exercise at different intensities: Decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Medicine, 41,* 641-671.

Ekkekakis, P., & Petruzzello, S. J. (1999). Acute aerobic exercise and affect: Current status, problems, and prospects regarding dose-response. *Sports Medicine, 28,* 337-374.

Ekkekakis, P., & Petruzzello, S. J. (2000). Analysis of the affect measurement conundrum in exercise psychology. I. Fundamental issues. *Psychology of Sport and Exercise, 1,* 71-88.

Ekkekakis, P., & Petruzzello, S. J. (2002). Analysis of the affect measurement conundrum in exercise psychology: IV. A conceptual case for the affect circumplex. *Psychology of Sport and Exercise, 3,* 35-63.

Ferguson, M. J., & Bargh, J. A. (2004). Liking is doing: The effects of goal pursuit on automatic evaluation. *Journal of Personality and Social Psychology, 87,* 557-572. DOI: 10.1037/0022-3514.87.5.557.

Finucane, M. L., Alhakami, A. L. I., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgment of risk and benefits. *Journal of Behavioural Decision Making, 13,* 1-17.

Focht, B. C. (2009). Brief walks in outdoor and laboratory environments: Effects on affective responses, enjoyment, and intentions to walk for exercise. *Research Quarterly for Exercise and Sport, 80,* 611-620, Doi:10.1080/02701367.2009.10599600

Focht, B. C., & Hausenblas, H. A. (2003). State anxiety responses to acute exercise in women with high social physique anxiety. *Journal of Sport and Exercise Psychology, 25,* 123–144.

Fontaine, J. R. J., Scherer, K. R., Roesch, E. B., & Ellsworth P. C. (2007). The world of emotions is not two-dimensional. *Psychological Science, 18,* 1050-1057.

Frederick, S., & Loewenstein, G. (1999). Hedonic adaptation. In D. Kahneman, E. Diener, & N. Schwartz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 302–329). New York: Russell Sage.

Fredrickson, B. L. (2010). Extracting meaning from past affective experiences: The importance of peaks, ends, and specific emotions. *Cognition and Emotion* 14(4): 577-606. Doi: 10.1080/026999300402808.

Gill, D. L., & Kamphoff, C. F. (2010). Gender in sport and exercise psychology. In: J. C. Chrisler and D. R. McCreary (Eds.), *Handbook of gender research in psychology* (471–494). London: Springer.

Ginis, K. A., Jung, M, E., & Gauvin, L. (2003). To see or not to see: Effects of Exercising in mirrored environments on sedentary women's feeling states and self-efficacy. *Health Psychology, 22,* 354-361. Doi: 10.1037/0278-6133.22.4.354

Godin, G., & Shephard, R. J. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Sciences, 10,* 141-146.

Goldberg, M.E., & Gunasti, K. (2007). Creating an Environment in Which Youths Are Encouraged to Eat a Healthier Diet. *Journal of Public Policy & Marketing*, 26, 162.

Granger, D. A., Kivlighan, K. T., el-Sheikh, M., Gordis, E. B., & Stroud, L. R. (2007). Salivary alpha-amylase in biobehavioral research: Recent developments and applications. *Annals of the New York Academy of Sciences, 1098,* 122-144.

Gulick, D. T., & Kimura, I. F. (1996). Delayed onset muscle soreness: What is it and how do we treat it. *Journal of Sport Rehabilitation, 5,* 234-243.

Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2002). The affective beneficence of vigorous exercise revisited. *British Journal of Health Psychology, 7,* 47-66.

Hardy, C. J., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology, 11,* 304-317.

Hargreaves, E. A., & Stych, K. (2013). Exploring the peak and end rule of past affective episodes within the exercise context. *Psychology of Sport and Exercise, 14,* 169-178.

Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., et al. (2007). Physical activity and public health: Updated recommendation for adults from the American college of sports medicine and the American heart association. *Circulation, 116,* 1081–1093.

Hausenblas, H. A., Campbell, A., Menzel, J. E., Doughty, J., Levine, M., & Thompson, J. K. (2013). Media effects of experimental presentation of the ideal physique on eating disorder symptoms: A meta-analysis of laboratory studies. *Clinical Psychology Review, 33,* 168-181. Doi: 10.1016/j.cpr.2012.10.011.

Hausenblas, H. A., Janelle, C. M., Gardner, R. E., & Focht, B. C. (2004), Viewing physique slides: Affective responses of women at high and low drive for thinness. *Journal of Social and Clinical Psychology, 23,* 45-60.

Hausenblas, H.A., Gauvin, L., Symons Downs, D., & Duley, A.R. (2008). Effects of abstinence from habitual involvement in regular exercise on feeling states: An ecological momentary assessment study. *British Journal of Health Psychology, 13,* 237–255.

Helfer, S. G., Elhai, J. D., & Geers, A. L. (2015). Affect and exercise: Positive affective expectations can increase post-exercise mood and exercise intentions. *Annals of Behavioral Medicine 49,* 269-279. Doi: 10.1007/s12160-014-9656-1.

Henderson, J. M. (2003). Human gaze control during real-world scene perception. *Trends in Cognitive Science, 7*, 498-504. Doi: 10.1016/j.tics.2003.09.006.

Herbert, R. D., de Noronha, M., & Kamper, S. J. (2011). Stretching to prevent of reduce muscle soreness after exercise. *Cochrane Database Systematic Review, 6,* CD004577, Doi: 10.1002/14651858.CD004577.

Hsee, C. K. & Hastie, R. (2006). Decision and experience: Why don't we choose what makes us happy? *Trends in Cognitive Sciences, 10,* 31-37.

Ingledew, D. K., & Markland, D. (2008). The role of motives in exercise participation. *Psychology and Health*, 23, 807-828. Doi: 10.1080/08870440701405704.

Jonason, P. K. (2007). An evolutionary psychology perspective on sex differences in exercise behaviors and motivations. *Journal of Social Psychology, 147,* 5-14.

Jones, F., Harris, P., Waller, H., & Coggins, A. (2005). Adherence to an exercise prescription scheme: The role of expectations, self-efficacy, stage of change and psychological well-being. *British Journal of Health Psychology, 10,* 359-378. Doi: 10.1348/135910704X24798.

Kahneman, D. (1999). Objective happiness. In: Kahneman D, Diener E, Schwarz N, editors. *Well-Being: Foundations of Hedonic Psychology*. Russell-Sage: New York.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*, 263–291.

Kahneman, D., Fredrickson, B. L., Schreiber, C. A., & Redelmeier, D. A. (1993). When more pain is preferred to less: adding a better end. *Psychological Science, 4,* 401-405.

Kahneman, D., Wakker, P., & Sarin, R. (1997). Back to Bentham? Explorations of experienced utility. *Quarterly Journal of Economics, 112,* 375-405.

Kanning M. & Schlicht W. (2010). Be active and become happy: an ecological momentary assessment of physical activity and mood. *Journal of Sport and Exercise Psychology, 32*, 253–261.

Kilpatrick, M. W., Robertson, R. J., Powers, J. M., Mears, J. L., & Ferrer, N. F. (2009). Comparisons of RPE before, during and after self-regulated aerobic exercise. *Medicine and Science in Sports and Exercise, 41,* 682-7. Doi: 10.1249/MSS.0b013e31818a0f09.

Kilpatrick, M., Kraemer, R., Bartholomew, J., Acevedo, E., & Jarreau, D. (2007). Affective responses to exercise are dependent on intensity rather than total work. *Medicine and Science in Sports and Exercise, 39,* 1417–22.

Kiviniemi, M. T., Voss-Humke, A. M., & Seifert, A. L. (2007). How do I feel about the behavior? The interplay of affective associations with behaviors andcognitive beliefs as influences on physical activity behavior. *Health Psychology, 26,* 152-158.

Koibuchi E, Suzuki Y. (2014). Exercise upregulates salivary amylase in humans (Review). *Experimental and Therapeutic Medicine, 7,* 773-777.

Kwan, B. M., & Bryan, A. (2010). In-task and post-task affective response to exercise: Translating exercise intentions into behavior. *British Journal of Health Psychology, 15,* 115-131.

LaCaille, R. A., Masters, K. S., & Heath, E. M. (2004). Effects of cognitive strategy and exercise setting on running performance, perceived exertion, affect, and satisfaction. *Psychology of Sport and Exercise, 5,* 461-476.

Lee, I.M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N. & Katzmarzyk, P. T. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an

analysis of burden of disease and life expectancy. *Lancet, 380,* 219-29. Doi: 10.1016/S0140-6736(12)61031.

Lind, E., Welch, A. S., & Ekkekakis, P. (2009). Do 'mind over muscle' strategies work? Examining the effects of attentional association and dissociation on exertional, affective, and physiological responses to exercise. *Sports Medicine, 30,* 743-764.

Lund, H., Vestergaard-Poulsen, P., Kanstrup, I. L., & Sejrsen, P. (1998). The effect of passive stretching on delayed onset muscle soreness, and other detrimental effects following eccentric exercise. *Scandinavian Journal of Medicine, 8,* 216-21.

Marketing online source (A). http://www.mastbusiness.com/bizguides/bg97/. Retrieved on 8.02.2013.

Marketing online source (B). http://www.marketing-schools.org/consumer-psychology/marketing-exercise-gyms.html. Retrieved on 10.03.2014.

Marteau, T. M. & Bekker, H. (1992). The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). *British Journal of Clinical Psychology. 31,* 301-306

Miron-Shatz, T., Stone, A., & Kahneman, D. (2009). Memories of yesterday's emotions: Does the valence of experience affect the memory-experience gap? *Emotion 9,* 885–891.

Morgan W. P. (1978). Mind of the marathoner. *Psychology Today, 11,* 38–49.

Nasuti, G., & Rhodes, R. E. (2013). Affective judgment and physical activity in youth: review and meta-analyses. *Annals of Behavioral Medicine, 45,* 357-376.

Nater, U. M., Rohleder, N. (2009). Salivary alpha-amylase as a non-invasive biomarker for the sympathetic nervous system: current state of research. *Psychoneuroendocrinology, 4,* 486-496.

Netz, Y., Zeev, A., Arnon, M., & Tenenbaum, G. (2008). Reasons attributed to omitting exercising: A population-based study. *International Journal of Sport and Exercise Psychology, 6*, 9-23.

O'Halloran, P. D., Murphy, G. C., & Webster, K. E. (2002). Measure of beliefs about improvements in mood associated with exercise. *Psychological Reports, 90,* 834-840. Doi: 10.2466/pr0.2002.

Parfitt, G., Eston R., & Connolly D. (1996). Physiological affect at different ratings of perceived exertion in high-and low-active women: a study using a production protocol. *Perceptual and Motor Skills, 82,* 1035–1042, Doi: 10.2466/pms.1996.82.3.1035

Parfitt, G., Hughes, S. (2009). The exercise intensity-affect relationship: Evidence and implications for exercise behavior. *Journal of Exercise Science and Fitness, 2,* 34-41.

Parfitt, G., Rose E. A., & Markland, D. (2000). The effect of prescribed and preferred intensity exercise on psychological affect and the influence of baseline measures of affect. *Journal of Health Psychology, 5,* 231–40.

Parfitt, G., Rose, E. A., & Burgess, W. M. (2006). The psychological and physiological responses of sedentary individuals to prescribed and preferred intensity exercise. *British Journal of Health Psychology, 11,* 39-53.

Pennebaker, J. W., & Lightner, J. M. (1980). Competition of internal and external information in an exercise setting. *Journal of Personality and Social Psychology, 39,* 165–174.

Prichard, I. & Tiggemann, M. (2012). Predictors of self-objectification in new female fitness center members. *Women in Sport and Physical Activity Journal, 21,* 24-32.

Pridgeon, L., & Grogan, S. (2012). Understanding exercise adherence and dropout: An interpretative phenomenological analysis of men and women's accounts of gym attendance and non-attendance. *Qualitative Research in Sport, Exercise and Health, 3,* 382-399. Doi:10.1080/2159676X.2012.712984.

Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change. Applications to addictive behaviours. *American Psychologist,* 47, 1102.

Rachman S, & Arntz A. (1991). The overprediction and underprediction of pain. *Clinical Psychology Review, 11,* 339–55.

Raglin, J. S., & Wilson, M. (1996). State anxiety following 20 minutes of bicycle ergometer exercise at selected intensities. *International Journal of Sports Medicine, 17,* 467-471. Doi: 10.1055/s-2007-972880.

Ratelle, C. F., Larose, S., Guay, F., & Senecal, C. (2005). Perceptions of parental involvement and support as predictors of college students' persistence in a science curriculum. *Journal of Family Psychology, 19,* 286 –293.

Redelmeier, D. A., & Kahneman, D. (1996). Patients' memories of painful medical treatments: Real-time and retrospective evaluations of two minimally invasive procedures. *Pain, 66,* 3-8.

Reed, J., & Ones, D. S. (2006). The effect of acute exercise on positive activated affect: A meta-analysis. *Psychology of Sport and Exercise, 7,* 477-514.

Rhodes, R. E., Fiala, B., Conner, M. (2009). A review and meta-analysis of affective judgments and physical activity in adult populations. *Annals of Behavioral Medicine, 38,* 180-204.

Rose, E. A., & Parfitt, G. (2008). Can the feeling scale be used to regulate exercise intensity? *Medicine and Science in Sports and Exercise, 40,* 1852–1860.

Rose, E. A., & Parfitt, G. (2010). Pleasant for some and unpleasant for others: a protocol analysis of the cognitive factors that influence affective responses to exercise. *International Journal of Behavioral Nutrition and Physical Activity, 7,* 1-15.

Rose, E. A., & Parfitt, G. (2012). Exercise experience influences affective and motivational outcomes of prescribed and self-selected intensity exercise. *Scandinavian Journal of Medicine and Sciences in Sports, 22,* 265-277. Doi: 10.1111/j.1600-0838.2010.01161.x.

Roseman, J. J. (1991). Appraisal determinants of discrete emotions. *Cognition and Emotion, 5,* 161-200.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39,* 1161-1178.

Russell, J. A. (1991). Culture and the categorization of emotions. *Psychological Bulletin, 110,* 426-450.

Ryan, R. M., Frederick, C. M., Lepes, D., Rubio, N., & Sheldon, K. M. (1997). Intrinsic motivation and exercise adherence. *International Journal of Sport Psychology, 28,* 335-254.

Saanijoki, T., Nummenmaa, L., Eskelinen, J., Savolainen,A. M., Vahlberg, T., Kalliokoski, K. K., & Hannukainen, J. C. (2015). Affective responses to repeated sessions high-intensity interval training. *Medicine & Science in Sport and Exercise, 47,* 2604-11. Doi : 10.1249/MSS.0000000000000721.

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sport and Exercise, 32,* 963-75.

Salmon, P. (2001). Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory. C*linical Psychology Review, 21,* 33-61.

Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In E.T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundation of Social Behavior* (pp. 527-561). New York: Guilford Press.

Schwarz, N., & Bohner, G. (1996). Feelings and their motivational implications: Moods and the action sequence. In P. M. Gollwitzer & J. A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 119-145). New York: The Guilford Press.

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. In E. T. Higgins & A. W. Kruglanski (Eds.), Social psychology: *Handbook of basic principles* (pp. 433- 465). New York: Guilford Press.

Siemer, M., Mauss, L., & Gross, J. J. (2007). Same situation – different emotions: How appraisal shape our emotions. *Emotion, 7,* 592-600.

Sjöström, M., Oja, P., Hagströmer, M., Smith, B.J., & Bauman, A. (2006). Health-enhancing physical activity across European union countries: The Eurobarometer study. *Journal of Public Health, 14,* 291–300.

Slawinska, M. M., Papaioannou, A. G., Chatzisarantis, N. L. D., Hatzigeorgiadis, A., & Davis, P. A. (2015). On relativistic nature of predicted and real physical experiences: A field experiment. *Psychology of Sport and Exercise, 16,* 106-111.

Spielberger, C. D., Gorsuch, R. L., Lushene, P. R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologists Press, Inc.

Steptoe, A., Kimbell, J., & Basford, P. (1998). Exercise and the experience and appraisal of daily stressors: A naturalistic study. *Journal of Behavioral Medicine, 21,* 363-374.

Steptoe, A., Wardle, J., Lipsey, Z., Mills, R., Oliver, G., Jarvis, M., & Kirschbaum, C. (1998). A longitudinal study of work load and variations in psychological well-being, cortisol, smoking, and alcohol consumption. *Annals of Behavioral Medicine, 20,* 84-91.

Stetson, B. A., Rahn, J. M., Dubbert, P. M., Wilner, B. I., & Mercury, M. G. (1996) Prospective evaluation of the effects of stress on exercise adherence in community-residing women. *Health Psychology, 16,* 515-520.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality & Social Psychology Review, 8,* 220-247.

Stults-Kolehmainen, M. A., & Sinha, R. (2014). The effects of stress on physical activity and exercise. *Sports Medicine, 44,* 81-121. Doi: 10.1007/s40279-013-0090-5.

Tenenbaum G. (2001). A social-cognitive perspective of perceived exertion and exertion tolerance. In R. N. Singer, H. A. Hausenblas, and C. Janelle (Eds.), *Handbook of Sport Psychology* (pp. 810-822), New York, NY: Wiley.

Tenenbaum, G., Hatfield, B. D., Eklund, R. C., Land, W. M., Calmeiro, L., Razon, S., & Schack, T. (2009). A conceptual framework for studying emotions-cognitions-performance linkage under conditions that vary in perceived pressure. *Progress in Brain Research, 174,* 158-179.

Thompson, J. K., & Heinberg, L. J. (1999). The media's influence on body image disturbance and eating disorders: We've reviled them, now can we rehabilitate them? *Journal of Social Issues, 55,* 339-353.

Troiano, R. P, Berrigan, D., Dodd, K. W., Mâsse, L. C., Tilert, T., McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and Science in Sport and Exercise, 40,* 181-8.

Trope, Y, & Liberman, N. (2003). Temporal construal. *Psychological Review, 110,* 403-421.

Tryon, W. W. (1994). Expectation. In V. S. Ramachandran (Ed.), Encyclopedia of human behavior (2nd ed, pp. 313). San Diego, CA: Academic Press.

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5,* 297-323.

Vartaanian, L. R., Wharton, C. M., & Green, E. B. (2012). Appearance vs. health motives for exercise and for weight loss. *Psychology of Sport and Exercise, 13,* 251-256. Doi: 10.1016/j.psychsport.2011.12.005.

Vazou-Ekkekakis, S., & Ekkekakis, P. (2009). Affective consequences of imposing the intensity of physical activity: does the loss of perceived autonomy matter? *Hellenic Journal of Psychology, 6,* 125–144.

Vygotsky, L. S. (1982). Consciousness as problem in the psychology of behavior. In A. R. Luria & M. G. Yarochevsky (Eds.), *Selected works* (Vol. 1, pp. 77–98). Moscow, Russia: Pedagogica.

Walton, V. R., & Finkenberg, M. E. (2002). Women's anxiety about social and exercise settings. *Perceptual and Motor Skills, 94,* 700-702.

Williams, D. M. (2008). Exercise, affect, and adherence: An integrated model and a case for self-paced exercise. *Journal of Sport and Exercise Psychology, 30,* 471-496.

Williams, D., Dunsiger, S., Ciccolo, J. T., Lewis, B. A., Albrecht, A. E., & Marcus, B. H. (2008). Acute affective response to a moderate-intensity exercise stimulus predicts physical activity participation 6 to 12 months later. *Psychology of Sport and Exercise, 9,* 231-245.

Williams, K. C., & Page, R. A. (2011). Marketing to the generations. *Journal of Behavioral studies in Business, 3,* 1-13.

Wilmore, J. H., Costill, D. L. (1999). Metabolism and basic energy systems. In: J. H. Wilmore, & D. L. Costill (Eds.), *Physiology of Sport and Exercise* (pp. 114–54, Champaign: Human Kinetics.

World Health Organization (2013). Physical inactivity: A global public health problem. Retrieved in May 2013 from: http://www.who.int/topics/physical_activity/en.htm.

Yeung R. R. (2006). The acute effects of exercise on mood state. *Journal of Psychosomatic Research, 40,* 123–141.

Zenko, Z., Ekkekakis, P., & Ariely, D. (2016). Can you have your vigorous exercise and enjoy it too? Ramping intensity down increases postexercise, remembered, and forecasted pleasure. *Journal of Sport and Exercise Psychology, 38,* 149-159.

8. Appendices

A GENERIC INFORMED CONSENT FORM

Project Title: Exercise motivation and evaluation of responses to an exercise bout.

Principal Investigator: Malgorzata Maria (Gosia) Slawinska

Participant Number:

	please tick where applicable
I have carefully read and understood the Participant Information Sheet.	☐
I have had an opportunity to ask questions and discuss this study and I have received satisfactory answers.	☐
I understand I am free to withdraw from the study at any time, without having to give a reason for withdrawing, and without prejudice.	☐
I agree to take part in this study.	☐
I would like to receive feedback on the overall results of the study at the email address given below. Email address malgorzata.slawinska@northumbria.ac.uk	☐

Signature of participant..... Date..... (NAME IN BLOCK LETTERS).....……
Signature of Parent / Guardian in the case of a minor .....
Signature of researcher..... Date..... (NAME IN BLOCK LETTERS).....……

Feeling Scale (FS)

How do you feel?
(Please circle the answer)

+5 Very good

+4

+3 Good

+2

+1 Fairly good

0 Neutral

-1 Fairly bad

-2

-3 Bad

-4

-5 Very bad

FELT AROUSAL SCALE (FAS)
(Svebak & Murgatroyd, 1985)

Estimate here how aroused you actually feel. Do this by circling the appropriate number. By "arousal" we 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.

1 LOW AROUSAL

2

3

4

5

6 HIGH AROUSAL

The Scale

Motives for Physical Activities Measure – Revised (MPAM-R)

The following is a list of reasons why people engage in physical activities, sports and exercise. Keeping in mind your primary physical activity/sport, respond to each question (using the scale given), on the basis of how true that response is for you.

1	2	3	4	5	6	7
not at all true for me						very true for me

___ 1. Because I want to be physically fit.

___ 2. Because it's fun.

___ 3. Because I like engaging in activities which physically challenge me.

___ 4. Because I want to obtain new skills.

___ 5. Because I want to look or maintain weight so I look better.

___ 6. Because I want to be with my friends.

___ 7. Because I like to do this activity.

___ 8. Because I want to improve existing skills.

___ 9. Because I like the challenge.

___ 10. Because I want to define my muscles so I look better.

___ 11. Because it makes me happy.

___ 12. Because I want to keep up my current skill level.

___ 13. Because I want to have more energy

___ 14. Because I like activities which are physically challenging.

___ 15. Because I like to be with others who are interested in this activity.

___ 16. Because I want to improve my cardiovascular fitness.

___ 17. Because I want to improve my appearance.

___ 18. Because I think it's interesting.

___ 19. Because I want to maintain my physical strength to live a healthy life.

___ 20. Because I want to be attractive to others.

___ 21. Because I want to meet new people.

___ 22. Because I enjoy this activity.

PILOT SURVEY

This pilot survey aims at identifying common cues individuals use when creating their judgment of motives for exercise.

Please take a look at the pictures below and rate to what extent do you feel they reflect stated motives:




	Extremely	Quite	Slightly	Not at all
Enjoyment/Interest Motives				
Competence Motives				
Appearance Motives				
Fitness/Health Motives				
Socialising Motives				

Thank you for you time!

How much effort did you put into the running: Example:

6	**No exertion at all**	
7		
8	**Extremely light**	
9	**Very light**	**/walking in the park**
10		
1 1	**Light**	
12		
13	**Somewhat hard**	**/It felt hard but OK to continue**
14		
15	**Hard (heavy)**	**/It felt hard and tiring but continuing is not terribly difficult**
16		
17	**Very hard**	**/ Very hard. It is very strenuous. You can still go on but you really have to push yourself**
18		
19	**Extremely hard**	**/An extremely strenuous level. For most people this is the most strenuous exercise they have ever experienced**
20	**Maximal exertion**	

PARTICIPANT DEBRIEF SHEET

1. What was the purpose of the project?
Being able to evaluate your responses to a physical task is very important for effective exercise program. Your emotional, cognitive and physiological processes impact how you engage in and how you progress with exercise in the future. People with more positive evaluations tend to maintain exercise programs because they have higher enjoyment and satisfaction of exercise.

The aim of this study was to see how you evaluated responses to exercise under three trials. In each trial you performed with a health/fitness or appearance related poster or no poster. These posters acted as contextual cues and may have influenced how you evaluated your responses to exercise. For example, if you are motivated for exercising for health/fitness reasons then you may have evaluated your responses more favourably when the health/fitness poster was present.

Thus, in this study we tested following research questions: 1) Whether or not evaluation of responses differs between the trials i.e., if one type of poster message is better than another for people's satisfaction and enjoyment of exercise? 2) Whether or not evaluation was influenced by the person's goal for exercise and the poster message being in agreement, as in the example?

2. How will I find out about the results?
Once the study has been completed and the data analysed, the researcher will email you a general summary of the results (approximately 12 weeks after taking part).

3. What will happen to the information I have provided?
Information and data gathered during this research study will be used by members of the research team only and only for the purposes appropriate to the research question. The data will be destroyed after a maximum of three years following the conclusion of the study.

4. How will the results be disseminated?
Should the research be presented or published in any form, then that information will be generalised however your personal information or data will not be identifiable.

5. Have I been deceived in any way during the project?
Yes. In this study you were asked to run on a treadmill on three separate days. Your performance however was manipulated without you being told by hanging posters in front of the treadmills for two out of the three trials. These posters contained contextual cues that aimed at influencing your evaluation. The remaining trial was treated as a control measurement without any contextual cues (i.e., no poster). We would like to apologise to you for this deception however it could not be possible to conduct this study if you were aware of this manipulation. If you had known the exact procedure it may have affected your results without you purposefully intending to.

6. If I change my mind and wish to withdraw the information I have provided, how do I do this?
If, for any reason, you wish to withdraw your data please contact the investigator within a month of your participation. After this date, it may not be possible to withdraw your individual data as the results may already have been published.

If you have any concerns or worries concerning the way in which this research has been conducted, or if you have requested, but did not receive feedback from the researcher concerning the general outcomes of the study within a few months after the study has concluded, then please contact Les Ansley via email at les.ansley@northumbria.ac.uk.

Thank you again for your participation!

INFORMATION SHEET

PROJECT TITLE: **Changes of exercise-related affect over time**

PRINCIPAL INVESTIGATOR: Malgorzata (Gosia) Slawinska

The purpose of this information sheet is to provide you with sufficient information so that you can then give your informed consent. It is thus very important that you read this document carefully, and raise any issues that you do not understand with the investigator.

1. What is the purpose of the project? We wish to examine changes in exercise-related feelings over time, in particular how individuals recall their exercise experience. The study is part of a bigger project that aims to examine how individuals evaluate their exercise related emotions with the purpose of enhancing exercise adherence and informing physical activity promotion.
2. Why have I been selected to take part? You have been invited to participate because you are an active, healthy adult (>18 years of age) therefore you will give the best overall results through this research.
3. What will I have to do? You will be asked to fill in a questionnaire about your personal, basic information including your age, gender, exercise history and to fill in a health screen questionnaire. Completing these questions should take no longer than 15 minutes. Next, in order to establish your fitness level we will conduct a treadmill exercise test, the VO2max test, which tests volitional fatigue which is a moment when you can not run any longer without cheating it up. The VO2max test involves a run on a treadmill with automatically increasing speed and grade of the treadmill. This test is used to measure the volume of oxygen which you breathe in and breathe out through a special mask fitted to your face. The test usually takes 10 minutes until you reach the exhaustion. You may feel tired immediately after the completion of the test however the feeling will quickly disappear. This test is routinely used in exercise physiology research. On a designated day you will be invited to Northumbria exercise physiology lab to run on a treadmill for 20 consecutive minutes during which every 5 minutes we will measure your affective responses by asking you to score on two 1-item scales. Once the exercise time is up, you will be required to complete a measure of affect at 5, 10 and 15 min post exercise. Finally, you will be provided with the link to an online survey where you will be asked to complete three 1-item measures of affect at 4, 8 hours, 24 hours, 48 hours, 1 week and 2 weeks after the exercise together with the reports on exercise behaviour. To assure the correct timing you will receive a text message from the researcher with a link to a survey 1 hour and again 5 minutes before the scheduled time. The data on exercise behaviour will be collected from a pedometer, which you will be asked to wear for 2 weeks following the initial testing (the 20min run).
4. What is the exclusion criteria (i.e. are there any reasons why I should not take part)? Participants need to be over 18 years of age, be free from an injury and should be able to perform a moderate or vigorous exercise without a risk of having a heart

northumbria UNIVERSITY NEWCASTLE

Name/Number .....

Health Screen Questionnaire for Study Volunteers

As a volunteer participating in a research study, it is important that you are currently in good health and have had no significant medical problems in the past. This is (i) to ensure your own continuing well-being and (ii) to avoid the possibility of individual health issues confounding study outcomes.

Please complete this brief questionnaire to confirm your fitness to participate:

1. At present, do you have any health problem for which you are:

(a)	on medication, prescribed or otherwise	Yes ☐	No ☐
(b)	attending your general practitioner	Yes ☐	No ☐
(c)	on a hospital waiting list	Yes ☐	No ☐

2. In the past two years, have you had any illness which required you to:

(a)	consult your GP.....	Yes ☐	No ☐
(b)	attend a hospital outpatient department.....	Yes ☐	No ☐
(c)	be admitted to hospital	Yes ☐	No ☐

3. Have you ever had any of the following:

(a)	Convulsions/epilepsy	Yes ☐	No ☐
(b)	Asthma	Yes ☐	No ☐
(c)	Eczema	Yes ☐	No ☐
(d)	Diabetes	Yes ☐	No ☐
(e)	A blood disorder	Yes ☐	No ☐
(f)	Head injury	Yes ☐	No ☐
(g)	Digestive problems	Yes ☐	No ☐
(h)	Heart problems	Yes ☐	No ☐
(i)	Problems with bones or joints	Yes ☐	No ☐
(j)	Disturbance of balance/coordination	Yes ☐	No ☐
(k)	Numbness in hands or feet	Yes ☐	No ☐
(l)	Disturbance of vision	Yes ☐	No ☐
(m)	Ear / hearing problems	Yes ☐	No ☐
(n)	Thyroid problems	Yes ☐	No ☐
(o)	Kidney or liver problems	Yes ☐	No ☐

5. Additional questions for female participants

(a)	are your periods normal/regular?	Yes ☐	No ☐
(b)	are you on “the pill”?	Yes ☐	No ☐
(c)	could you be pregnant?	Yes ☐	No ☐
(d)	are you taking hormone replacement therapy (HRT)?	Yes ☐	No ☐

PSS

INSTRUCTIONS:

The questions in this scale ask you about your feelings and thoughts during THE LAST MONTH. In each case, please indicate your response by placing an "X" over the circle representing HOW OFTEN you felt or thought a certain way.

	Never 0	Almost Never 1	Sometimes 2	Fairly Often 3	Very Often 4
1. In the last month, how often have you been upset because of something that happened unexpectedly?	○	○	○	○	○
2. In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
3. In the last month, how often have you felt nervous and "stressed"?	○	○	○	○	○
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	○	○	○	○	○
5. In the last month, how often have you felt that things were going your way?	○	○	○	○	○
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	○	○	○	○	○
7. In the last month, how often have you been able to control irritations in your life?	○	○	○	○	○
8. In the last month, how often have you felt that you were on top of things?	○	○	○	○	○
9. In the last month, how often have you been angered because of things that were outside your control?	○	○	○	○	○
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	○	○	○	○	○

Faculty of Health & Life Sciences

SF State Anxiety

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the most appropriate number to the right of the statement to indicate **how you feel right now, at this moment**. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

		Not at all	**Somewhat**	**Moderately**	**Very much**
1	I feel calm	1	2	3	4
2	I feel tense	1	2	3	4
3	I am upset	1	2	3	4
4	I feel relaxed	1	2	3	4
5	I feel content	1	2	3	4
6	I am worried	1	2	3	4

Global Affective Evaluation (GAE) – Anticipation

Please rate the overall amount of pleasantness or unpleasantness you expect to feel in the upcoming exercise trial.

-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
very unpleasant experience										*neutral experience*										*very pleasant experience*

Global Affective Evaluation (GAE)

Please rate the overall amount of pleasantness or unpleasantness that was experienced during the last trial of exercise.

-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
very unpleasant experience										*neutral experience*										*very pleasant experience*

PARTICIPANT DEBRIEF SHEET

1. What was the purpose of the project?
Being able to evaluate your responses to a physical task is very important for developing effective exercise programs in the future. Your emotional, cognitive and physiological processes impact how you currently engage with exercise and how you may undertake exercise in the future. People with more positive evaluations tend to maintain exercise programs because they have greater enjoyment and satisfaction from exercise.

The aim of this study was to examine how you evaluate your experience of exercise over time. In particular we were investigating your memories of exercise and the influence of the passage of time on exercise related feelings.

We tested the following research questions: 1) Whether exercise-related affect would change over time? 2) Whether the mechanisms of recall (i.e., how you remember exerise) would be affected by negative/positive feelings from exercise?

2. How will I find out about the results?
Once the study has been completed and the data analysed, the researcher will email you a general summary of the results (approximately 16 weeks after taking part).

3. What will happen to the information I have provided?
Information and data gathered during this research study will be only be used by members of the research team and only for the purposes that are related to the research question. The data will be destroyed after a maximum of three years following the conclusion of the study.

4. How will the results be disseminated?
Should the research be presented at an academic conference or published in an academic journal the information will be generalised and your personal information and data will not be identifiable.

5. Have I been deceived in any way during the project?
No, You have not been deceived in any way during this study.

6. If I change my mind and wish to withdraw the information I have provided, how do I do this?
If, for any reason, you wish to withdraw your data please contact the investigator within a month of your participation. After this date, it may not be possible to withdraw your individual data as the results may already have been published.

If you have any concerns or worries concerning the way in which this research has been conducted, or if you have requested, but did not receive feedback from the researcher concerning the general outcomes of the study within a few months after the study has concluded, then please contact Dr. Les Ansley via email at les.ansley@northumbria.ac.uk.

Thank you again for your participation!

INFORMATION SHEET

PROJECT TITLE: **Recall of exercise related affect, affect appraisal and a level of perceived and real experienced stress.**

PRINCIPAL INVESTIGATOR: Malgorzata Maria (Gosia) Slawinska

The purpose of this information sheet is to provide you with sufficient information so that you can then give your informed consent. It is thus very important that you read this document carefully, and raise any issues that you do not understand with the investigator.

1. What is the purpose of the project? We wish to examine people's feelings about completing a specific session of exercise and to see if how they recall these feelings changes over time. The study is part of a bigger project that is examining how individuals consider their feelings about exercise and how they relate to being physically active.
2. Why have I been selected to take part? You have been invited to participate because you are an active, healthy adult (>18) therefore you will give the best overall results through this research.
3. What will I have to do? In order to participate in this study you will be asked to commit approximately 3 hours of your time across 4 consecutive days with two days involving exercise trials (run on a treadmill) at a self paced intensity. Specifically, first you will be asked to come to a lab for an introductory session which will last around 30-45 minutes. During this session we will ask you to fill in a number of short questionnaires about your basic information including your age, gender, and exercise history. Completing these questionnaires should take no longer than 15 minutes. During this session you will also be familiarised with the salivary sampling. To give a sample of saliva you will be required to use an oral swab that will be kept in the mouth for 1-2 minutes to ensure that it is saturated. You will be required to provide 4 salivary samples throughout the study, during a baseline measurement, on two exercise days and on one day in between the exercise trials. After the familiarisation, you will be given a diary to provide two daily entries on specified times, and an activity monitor to wear for the entire duration of the study. On a designated day you will be invited to come to one of the Northumbria University physiology labs and will be ask to run on a treadmill for 20 consecutive minutes at self-selected intensity during which we will measure your feelings by asking you to score on three 1-item scales. Once the exercise time is up, you will be required to complete a measure of your feelings at 1, 5 and 15 min post exercise. Finally, we will arrange with you for either an email or text to be sent to you to complete three 1-item measures about your feelings at 4 hours and 8 hours after the exercise together and a short report of your exercise behaviour. 24 hours after the exercise session you will be asked to provide a salivary sample in the lab. On that day you will be asked to complete the entries of your diary and provide the same measures via text or email. After 48 hours you will be asked to come back to the laboratory, provide a salivary sample and perform the second exercise session, with the same self-selected exercise intensity.
4. What is the exclusion criteria (i.e. are there any reasons why I should not take

CONSENT FORM FOR TISSUE REMOVAL, USE AND STORAGE

Participant Identification Number for this trial:

Title of Project: Recall of exercise related affect, affect appraisal and a level of perceived and real experienced stress

Name of Researcher: Malgorzata Maria (Gosia) Slawinska

I confirm that:

I have read, and understand, the information sheet dated
I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

I agree that:

The following tissue or other material may be taken and used for the study :

Please tick one of the small boxes below and initial the end of the relevant statement. I also agree that:

❑ Northumbria University may store this tissue or other material in a Licensed Tissue Bank only for the duration of this study

❑ Northumbria University may continue to store this tissue for use, at its discretion, in properly approved local research or teaching programs

Please tick and initial the relevant boxes below

- Northumbria University may distribute this tissue to partners in this study, outside the university, for further testing **Yes No**
- Information about my tissue may be kept on the Tissue Bank database **Yes No**
- Such information may be passed in an anonymous form to persons outside Northumbria University in connection with this study and may be published with any research findings **Yes No**

I accept that I have given my consent voluntarily to the storage of this additional tissue and that I am free to withdraw my consent at any time.

I agree to take part in the above study

_____ Name of Participant _____ Date

_____ Signature of Participant

_____ Name of person taking consent _____ Date

_____ Signature of person taking consent

Northumbria University
Research Ethics Data Form: 3.4
Version 3 (20 October 2011)

Human tissue

If your research study uses human tissue, all of the questions on this form must be completed and the form included as part of your research ethics submission.

To complete the form, please type your responses into the text boxes, which will expand to accommodate the information you provide. For questions with the option of 'yes/no', please click on the appropriate box and type '**X**'.

Depending on your research study, you may need to include supporting documentary evidence as part of this form. Please refer to the research ethics guidelines for your academic school for information about the type of evidence you need to provide.

Research ethics number: *Taken from Research Information tab of online form.*	RE-HLS-HLS-12-160413
Project title:	Affective responses and recall mechanisms in exercise

1. Research samples

Provide details of the type of human tissue samples (e.g. blood, oral fluids, urine, saliva) and the number of samples the research study will collect and/or examine.

In this study samples of saliva will be collected with objective of analysing an alpha-amylase enzyme.

Will this research study use samples that have been collected by another organisation or institution?

☐ Yes ☒ No

If yes: Provide details of the supplier (company or institution name, address and telephone number). Describe any measures that will be put in place to meet the supplier's terms and conditions. (Note: arrangements about anonymising data, data storage and security should be provided in question 4).

Will this research study involve collecting samples from research participants?

Godin Leisure-Time Exercise Questionnaire

1. During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write on each line the appropriate number).

	Times Per Week
a) **STRENUOUS EXERCISE** **(HEART BEATS RAPIDLY)** (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)	_____
b) **MODERATE EXERCISE** **(NOT EXHAUSTING)** (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)	_____
c) **MILD EXERCISE** **(MINIMAL EFFORT)** (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)	_____

2. During a typical **7-Day period** (a week), in your leisure time, how often do you engage in any regular activity **long enough to work up a sweat** (heart beats rapidly)?

OFTEN	SOMETIMES	NEVER/RARELY
1. ☐	2. ☐	3. ☐

PARTICIPANT DEBRIEF SHEET

1. What was the purpose of the project?
Being able to evaluate your responses to a physical task is very important for developing effective exercise programs in the future. Your emotional, cognitive and physiological processes impact how you currently engage with exercise and how you may undertake exercise in the future. People with more positive evaluations tend to maintain exercise programs because they have greater enjoyment and satisfaction from exercise.

The aim of this study was to examine how you evaluate your experience of exercise over time. In particular we were investigating your memories of exercise and the influence of the passage of time on exercise related feelings.

We tested the following research questions: 1) Whether exercise-related affect would change over time? 2) Whether the mechanisms of recall (i.e., how you remember exerise) would be affected by negative/positive feelings from exercise?

2. How will I find out about the results?
Once the study has been completed and the data analysed, the researcher will email you a general summary of the results (approximately 16 weeks after taking part).

3. What will happen to the information I have provided?
Information and data gathered during this research study will be only be used by members of the research team and only for the purposes that are related to the research question. The data will be destroyed after a maximum of three years following the conclusion of the study.

4. How will the results be disseminated?
Should the research be presented at an academic conference or published in an academic journal the information will be generalised and your personal information and data will not be identifiable.

5. Have I been deceived in any way during the project?
No, You have not been deceived in any way during this study.

6. If I change my mind and wish to withdraw the information I have provided, how do I do this?
If, for any reason, you wish to withdraw your data please contact the investigator within a month of your participation. After this date, it may not be possible to withdraw your individual data as the results may already have been published.

If you have any concerns or worries concerning the way in which this research has been conducted, or if you have requested, but did not receive feedback from the researcher concerning the general outcomes of the study within a few months after the study has concluded, then please contact Dr. Les Ansley via email at les.ansley@northumbria.ac.uk.

Thank you again for your participation!