2009

Influence of affective response at the end of exercise on future exercise choice in low-active, overweight participants

Shenbaga Soundarapandian
Iowa State University

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by

Shenbaga SoundaraPandian

A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Kinesiology (Behavioral Basis of Physical Activity)

Program of Study Committee:
Amy Welch, Major Professor
Rick Sharp
Warren Franke

Iowa State University

Ames, Iowa

2009

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ABSTRACT

PURPOSE: Approximately 35-50% of individuals who start an exercise program have been reported to drop-out within the first few months (e.g., Dishman & Buckworth, 1997). Suggestions have been made that affective experience of exercise is linked to adherence, but only a limited amount of research has been conducted in this area. Also, none of these studies measured the influence of affective experiences during exercise on future choice. Identifying exercise that results in a positive affective experience may increase adherence. A theory that has found support in other fields is the *Peak-End* hypothesis (Kahneman et al., 1993). It suggests that individuals' positive affective experience and subsequent decisions about a behavior are derived from the peak affective moment and the final moments while engaged in the behavior. An episode with a pleasurable peak at the end will be remembered as positive even if it is longer than another episode with no pleasurable peak at the end (a concept known as *Duration Neglec*t). Therefore, the purpose of this study was to determine whether adding a positive end to an unpleasant exercise bout will influence the choice to repeat an exercise bout and to test whether exercise duration plays a role in this choice. METHODS: 27 overweight and low-active young adults (14 males, mean age 26 yrs) completed an incremental treadmill exercise test to determine ventilatory threshold (VT). They then completed two counterbalanced exercise sessions: one at 10% above VT for 20 minutes and one at 10% above VT for 20 minutes followed by 2.5 mph, 0% grade for 5 minutes. Given that exercising above VT has been shown to elicit predominantly negative responses and exercising below VT elicits a positive affective response, these workloads were designed to result in a peak negative end affect and a peak positive end affect,

respectively. Feeling Scale scores were measured before, during, and after exercise in both the sessions. In a final session, participants were asked to choose to repeat one of the two exercise bouts. RESULTS: Participants were twice as likely to choose to repeat the exercise bout that ended positively over the one that ended negatively, even though it was longer and involved more work overall. CONCLUSION: The results support the Peak-End and Duration neglect hypotheses in an exercise setting. To promote adherence, exercise prescriptions should put emphasis on a pleasurable (i.e. reduced intensity) end to each exercise bout.

CHAPTER 1. INTRODUCTION

In recent years, the efficacy of exercise as an effective treatment strategy to maintain health and treat disease states has been brought to the forefront of the health science literature. Knowledge about exercise and its benefits in treating chronic diseases such as cardiac diseases and diabetes is well-documented (Blair, Horton, Leon, Lee, Drinkwater, & Dishman, 1996), and physical inactivity and overweight status have been linked to major health issues and premature deaths (Ogden, Carroll, McDowell, & Flegal, 2007). However, while numerous physiological and psychological health benefits have been reported with participation in physical activity, inactivity is a challenging public health concern (Blair et al., 1996).

From a psychological standpoint, one of the major factors that hinder participation in exercise is lack of motivation to participate and adhere to an exercise regimen (Mears & Kilpatrick, 2008). Affective responses (pleasure/displeasure) during physical activity have recently been found to be related to future self-reported physical activity participation (Williams et al., 2008). It has been suggested that when an individual has a positive affective experience during and after involvement in physical activity, the person will be more inclined to repeat it (Wankel, 1993). Though pleasure responses reported during physical activity have been linked to higher physical activity participation (Williams et al., 2008), only a limited amount of research has been conducted in this area (Reed & Ones, 2006), and none of these studies measured the influence of the affective experiences of exercise on future choice of exercise. Thus, it is necessary to explore whether some patterns of affective experiences lead to enhanced liking of the exercise. Prescribing physical activities that create a pleasure

response might in turn pave the way for increasing participation and adherence to exercise. The “Peak, End and Duration Neglect” hypotheses (Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993) are theories that may be useful in understanding the effect of actual exercise characteristics on decisions about repetition of an activity. The Peak-End hypothesis suggests that individuals’ affective experience and subsequent choice about participation are derived from two specific moments while engaged in a behavior. The two moments are the moment of peak affective experience and the final moment of involvement (Kahneman et al., 1993). Also, the episode with pleasurable peak and end will be remembered as a positive experience even if it is longer than another episode with no pleasurable Peak and End – the ‘Duration Neglect’ hypothesis (Kahneman et al., 1993). Thus, if this theory were to hold true in an exercise context, participants should find one exercise bout as more pleasurable than another if it includes an affectively pleasant period at the end of the exercise, irrespective of how long the exercise bout lasts.

Kahneman and colleague’s hypotheses (1993) hold promise for explaining the impact of affective responses to exercise on future physical activity choices, yet it has not yet been tested in an exercise context. As mentioned earlier, investigation of these concepts in an exercise setting could help further our knowledge about ways to enhance adherence to exercise programs. The goal of this investigation was to design an exercise bout that ends with an overall positive affective experience and to test whether this impacts choice of exercise.

Strong links have been found between the affect experienced during exercise bouts and the intensity of the exercise (Hall, Ekkekakis, & Petruzzello, 2002a; Welch, Hulley,

Ferguson, & Beauchamp, 2007). Various studies have found that individuals tend to report positive affect at lower intensities (Bixby, Spalding, & Hatfield, 2001; Ekkekakis, Hall, & Petruzzello, 2005b; Ekkekakis & Lind, 2006; Ekkekakis, Hall, & Petruzzello, 2008; Hall, Ekkekakis, & Petruzzello, 2002b; Welch et al., 2007) and they have a lower tolerance for higher intensities of physical activity (Ekkekakis & Lind, 2006). Given these associations between affective experiences during exercise and exercise intensity, further research to test whether high intensity exercise results in negative affect and low intensity exercise results in positive affect is warranted.

Therefore, the overall objective of this study was to test the "End" and "Duration Neglect" rules in an exercise context. The first hypothesis of this study was that participants' affective experience at the end of an exercise event would be positive if a reduced intensity period of exercise was added at the end of an exercise bout. A second hypothesis was that when given a choice of which exercise bout to repeat, participants would be more likely to choose an exercise bout that ends with a positive affective experience, even if it was longer, over an exercise bout that ends negatively.

CHAPTER 2. LITERATURE REVIEW

Despite substantial evidence that exercise is beneficial for psychological and physiological well being (Blair et al., 1996), about two-thirds of the adults in the United States are inadequately active (National Center for Health Statistics, 2006). Physical inactivity and overweight status contribute to the occurrence of major chronic diseases (Mokdad, Marks, Stroup, & Gerberding, 2004). One of the approaches to deal with this problem is to increase the positive affective responses and the enjoyment of an activity (Berger, 1996). Various social, environmental and personal factors can contribute to participation in exercise; while affective state is another important contributor to increase participation (Kiviniemi, Voss, & Seifert, 2007) it has been largely neglected by researchers.

Affect and Behavior

In the general psychology literature, it has been argued that the cognitive processing of information is different for appraisal of retrospective data compared to appraisal of current feelings (Kahneman et al., 1999**;** Ariely, & Carmon, 2003). The overall evaluation of the affective experience after individuals take part in an activity is not just the sum of the affective experiences while they were involved in the behavior (Fredrickson & Kahneman, 1993). Before involvement in any kind of volitional behavior, a decision about whether to participate in an activity comes from the previous experiences of being involved in the same activity (Kahneman, Wakker, & Sarin, 1997). The past affective experience plays a major role in decision-making and people tend to repeat the behavior that they previously enjoyed (Lowenstein & Schkade, 1999) and avoid the disliked (affectively negative) experience (Fredrickson & Kahneman, 1993).

The Peak-End Rule

According to Kahneman et al. (1993), the peak affect (positive or negative affect) and the final affect experienced during an episode are the most important determinants of the global evaluations of the episode. It has been found that this memory is not formed from every moment of participation but by only certain moments which acted as a stronger driving force (Schkade & Kahneman, 1998). The construction of global evaluations of the past experience (Ariely & Carmon, 2000) forms the basis of recall and judgment. The overall judgment of any volitional behavior may be based on two moments: the moment of peak affective experience during the episode and the end affective experience (Kahneman et al., 1993). This is termed the Peak-End rule. When this overall evaluation of the previous episode is considered, the peak and the final moments are the well-remembered, recalled moments which will contribute to the choice.

Research Investigating the Peak-End Rule.

This theory has not been tested systematically in exercise science, yet research exploring the peak–end rule (Kahneman et al., 1993) in the context of other volitional behaviors suggests that it may hold promise for improving our understanding of decisions about exercise. For example, the rule has been illustrated in the contexts of pain and discomfort (Frederickson & Kahneman, 1993; Varey & Kahneman, 1992), marketing (Ariely & Zauberman, 2000; Baumgartner, Sujan, & Padgett, 1997), behavior when involved in a relationship (Fredrickson, 2000), viewing film clips (Frederickson & Kahneman, 1993), pain levels (Varey & Kahneman, 1992; Ariely et al., 2000), preference in order of life events (Diener, Wirtz, & Oishi, 2001; Ross & Simonson, 1991; Varey et al., 1992), choice of entertainment (Do, Rupert, & Wolford, 2008) and listening to music (Rozin, Rozin, &

Goldberg, 2004). Some of the research that was at the forefront of the development of this theory is presented below.

In the first breakthrough research leading to the proposal of the Peak-End rule, participants immersed one hand in water at 14.1° C for 60 s (Kahneman et al., 1993). In another trial, the same participants immersed the same hand in water at 14.1° C for 60 s followed by 30 s where the temperature was raised gradually to 15.2° C. When participants were given a choice to repeat the session they preferred, they selected to repeat the 90 s session, despite the longer trial involving more total pain. This choice was explained using the Peak-End rule. The fact that the session ended with less pain appeared to mean that the participants remembered it as inducing less pain. Therefore, if the Peak-End rule (Kahneman et al., 1993) is shown to be true in exercise settings physical activity might be evaluated as a more positive experience as long as it includes an ending which is enjoyable.

Another important finding noted from this study was that, all other factors being equal, individuals chose to repeat the behavior that was less painful even though it was longer. Duration of the episode did not matter. This phenomenon was termed “duration neglect.” In another study (Frederickson & Kahneman, 1993), participants rated their pleasure/displeasure (every minute and overall evaluation at the end of the whole session) of emotional film clips. The film clips included pictures such as ocean waves and amputated limbs. To prevent fluctuation of affective experience during the show, the film clips were random pictures and were plotless. The film was manipulated to end with a positive note or a negative note while the affective valence remained constant during the rest of the show. Results showed that the remembered affect was explained by the affect rating at the moment

of most intense level of pleasure/displeasure and the end of the film. Also, the duration of the clip did not influence the retrospective global rating. Ratings did not change based on whether the participant viewed a clip for 30s or for 60s. When the participants were asked only for an overall evaluation of the episode (without moment-to-moment rating which might be an interruption to the real episode itself), duration neglect was found to be more significant than an episode where they did moment-to-moment rating. It should be noted that these were very short experiences. Typically, exercise is a comparatively longer episode. Generalization of these findings to an exercise setting is therefore difficult. Hence, it is important to test these hypotheses specifically in an exercise setting.

Based on the above-mentioned findings, it can be stipulated that the Peak-End rule (Kahneman et al., 1993) has found support in situations where the affective valence of the experience involves short duration of events. However, exercise is a stimulus during which the affective valence changes throughout the activity (e.g., Welch et al., in press; Ekkekakis et al., 2008), and exercise is typically a much longer episode. Therefore, research that extends the Peak-End rule (Kahneman et al., 1993) to situations with changing affective states is discussed below. Perceived pain levels of outpatients (n=628) scheduled to undergo colonoscopy or lithotripsy, were measured during and immediately after the procedure (Redelmeier & Kahneman, 1996). The participants were randomized into either of two groups, modified care or standard care. The total duration of the episode varied from 4 to 67 minutes for colonoscopy and from 18 to 51 minutes for lithotripsy (these durations are comparable to typical exercise durations). In the modified care group, the outpatient surgical procedure was extended up to 3 minutes of final moments where the colonoscope was

retained in the rectum. This added portion increased the duration and reduced the pain level during the final moments of the procedure. Initial, peak, end, and overall evaluation of pain were measured using a handheld device. The device had end-points ranging from 0 indicating "no pain" to 10 indicating "extreme pain." Again, it was found that patients' global evaluation of the medical procedure was significantly correlated with the peak negative intensity of pain as well as the pain levels during the final minutes of the procedure. Prolonging the procedure lessened the remembered pain of patients. This global evaluation predicted individuals' participation in colonoscopy after 5 years. Further studies have shown that patients did not remember a lengthy procedure as painful/aversive which adds value to the duration neglect hypothesis (Ariely & Loewenstein, 2000; Redelmeier & Kahneman, 2003).

If duration neglect is found to be true in exercise settings, it has important applications. A longer exercise session might not be remembered as an aversive bout if it includes a pleasurable end. Duration and frequency of exercise form a major part of exercise prescriptions (Haskell et al., 2007). Thus, the potential finding that duration is not a major determinant of choice of exercise as long as the exercise creates a positive affect could contribute to a change in dimensions of exercise prescriptions aimed at promoting adherence.

Moderate intensity physical activity is considered by some individuals as positive and by others as negative (Ekkekakis et al., 2005b). If it is to have any relevance in the exercise setting, the Peak-End rule (Kahneman et al., 1993) has to hold good for experiences that are rated at both ends of the affect continuum. The Peak-End hypothesis (Kahneman et al., 1993) has also been applied to a desirable behavior (Do, Rupert, & Wolford, 2008). Do et al. (2008)

investigated whether individuals rated a highly positive experience as less pleasurable if a less positive experience was added at the end. The highly positive experience was receiving a highly desirable all-time favorite DVD. The less positive experience was receiving a DVD that was rated as less favorite. It was found that though participants received two DVDs in one of the conditions, namely they received a more desired movie followed by a less desired movie; they rated it less pleasurable than a condition where they received only one DVD, which was the highly desired one.

In another study, listeners' affective experience of music (a desirable stimulus) was measured during and after they heard between 40 seconds and 3 minutes of music. Their future choice was found to be influenced by the peak moment and the final moment (Rozin et al., 2004). Listeners also exhibited duration neglect while they made their choice. However, the initial selection of music was done by the researchers, so participants' previous enjoyment of a musician or music previously heard might have influenced the participants' future choice. Another limitation of this study was that various types of music were used and so the question of whether the choice would differ for a continuous, single piece of music was not answered. Research on retrospective affect ratings of meals also confirmed duration neglect (Rode, Rozin, & Durlach, 2004). However, there were minimal effects of the peak and end moments on the retrospective evaluation of a meal.

Thirty-five rheumatoid arthritis patients reported their mood, pain level, and disability on a 7-point scale consecutively for seven days in a study that examined the Peak-End rule (Kahneman et al., 1993) in day-to-day life experiences (Stone, Broderick, Kaell, DelesPaul, & Porter 2000). Also, a 7-day recall of pain level was recorded at the end of the week. These

variables were measured and correlated with the long-term pain level reported during their physician office visit. Neither peak pain level nor end pain level singly correlated as predictors of long-term recall. However, the averaged value of peak pain and end pain were significant predictors of recalled long-term total pain. The above-mentioned study extended the findings of the Peak-End rule to long-term experiences in real-world settings. One of the drawbacks of this study was that the participants were prompted to rate their pain level 7 times a day by a wristwatch. Prompting may have made the participants think about the pain when they otherwise might not have noticed the pain during normal circumstances, which may have altered the results.

Although certain aspects of the situations examined in the above-mentioned studies mimic exercise behavior, none of them are exactly similar to an exercise context. While the evidence for the Peak-End hypothesis (Kahneman et al., 1993) is robust in other behavioral settings, it is important to determine whether overweight low-active individuals make choices based on certain key aspects of the episode – particularly the peak affective experience and the end affective experience.

Exercise Intensity and Affect

Exercise intensity is one criterion that has been found to determine pleasure/displeasure of individuals while they exercise (Ekkekakis & Petruzzello, 1999). A point that has been found to be particularly important in determining individual's affective responses is the ventilatory threshold (VT; Hall et al., 2002a; Ekkekakis, 2003). VT is the threshold of transition to an exercise intensity at which the physiological mechanisms switch from predominantly aerobic to predominantly anaerobic metabolism (Whipp, 1996). Exercise

above VT is associated with physiological changes such as a marked rise in blood lactate concentration and a marked nonlinear increase in expired carbon dioxide relative to the consumed oxygen. These physiological changes in the human body are associated with negative affect (Cabanac, 2006; Ekkekakis et al., 2004). Therefore, determining exercise intensity based on VT has been shown to be a better method of calculating exercise intensity (Ekkekakis et al., 1999).

Affective valence (pleasure/displeasure) before, during, and after VT has been measured in a number of studies in order to investigate the role of VT in driving affective responses (Bixby et al., 2001; Ekkekakis et al., 2005b; Ekkekakis et al., 2006; Ekkekakis et al., 2008; Hall et al., 2002a; Welch et al., 2007). In a recent study, affective responses to exercise were measured while 30 normal-weight participants exercised on a treadmill for 20 minutes (including a 5-minute warm-up) at three different intensities on three separate days (Ekkekakis et al., 2008). In one of the sessions where participants exercised at low intensity (20% below VT) the affective rating was pleasurable in most individuals. Exercise performed around VT had mixed affective responses meaning some individuals feel pleasure while others feel displeasure (Ekkekakis et al., 2005a). In another session where the intensity of exercise exceeded VT (10% above VT), the participants reported a more negative affective rating. Hence, VT is a better marker for manipulation of the affective reactions to exercise.

In another study involving overweight participants; it was found that performance of physical activity just above the aerobic threshold (10% above VT) served as a stimulus of displeasure (Ekkekakis et al., 2006). This study extends the findings about the relationship between exercise intensity and affect (Ekkekakis et al., 2008) to overweight, inactive

individuals. Therefore, it can be concluded that exercise below VT is likely to induce positive affective responses during exercise in most individuals, and exercise above VT will most likely induce negative affective responses.

While a number of studies in different areas of research have examined the influence of affective experiences during a behavior on retrospective ratings and future choice, this concept has not been directly tested in the exercise literature. Exercise experience is different from most of the experiences investigated so far in the context of affect-based decision making. However, there have been two studies to date that looked at the effect of a cool-down (i.e. low-intensity exercise) on affect and perceived aversiveness of exercise. In one of those studies, retrospective ratings of the experience were used (Kilpatrick et al., 2003). Undergraduate students (n=29) took part in three sessions of exercise on a cycle ergometer at constant intensity. At the end of each exercise bout, there was a 10-minute cool-down at different concluding intensities namely a final part at 60% of maximal VO_2, a final part at 80% of maximal VO_2, or a final part with graded cool-down where the intensity reduced gradually. Affect was measured using the Subjective Exercise Experience Scale (McAuley & Courneya, 1994) and a 7-point scale ranging from not enjoyable to very enjoyable. Measurements made immediately after the exercise bout were compared with 15-minute post-exercise scores. Enjoyment was higher in the exercise session with a cool-down (60% of VO_2 max) when compared to the other two sessions.

However, there were a number of methodological issues in this study that make it difficult to draw conclusions from its findings. In the first session, used to determine the maximal oxygen uptake, the measurement of oxygen was made only once every 30 seconds,

thus, calculations were based on a single breath which might give gross approximations of actual VO_2max. Further, the activity levels of the participants were not mentioned. If individuals' activity level changed recently before the study or during the study, that may have altered their physiological and psychological responses to exercise. Nevertheless, the findings show that addition of a low intensity session (cool-down) at the end of an exercise bout increased participants' enjoyment.

Brewer et al. (2000) measured the impact of exertion during exercise on perception of aversiveness. In study one, 90 undergraduate students were given two imaginary scenarios of exercise and asked to evaluate the affective experiences of the imaginary exercise based on exertion ratings given by the researcher. The 'exercisers' imagined biking either for 15 minutes where the exertion level increased progressively or 20 minutes where the exertion increased progressively for the first 15 minutes followed by reduced exertion till the 20th minute. It was found that the 20-minute trial was rated as less aversive than the 15-minute trial. In study two of the same manuscript, there were three trials. In trial 1, participants did a baseline cycle ergometer test. For trial 2 and 3, the workloads were calculated based on the heart rate of trial 1. In these two sessions, the participants exercised for 15 minutes (the workload was adjusted to increase the heart rate progressively) or 20 minutes; similar to the other sessions during the first 15 minutes followed by a 5-minute reduced intensity at a heart rate of 130 bpm. Both sessions ended with 4 minutes of cool-down. Measurements included RPE every 2:30 minutes and perceived aversiveness rating at the end of each exercise bout. The aversiveness score was lower in the 20-minute session when compared to the 15-minute session. Though exertion trends were related to the aversiveness rating on the overall

evaluation of the two exercises, one half of the participants found one of the sessions to be less pleasurable while the other half found the other session as less pleasurable.

Although this was in many ways a well-conducted study, there were some methodological issues. One major flaw was that a cool-down was included in both experimental sessions, and therefore (based on the inverse intensity-affect relationship; e.g., Ekkekakis et al., 2008) means that both the exercise sessions most likely ended with a positive affect. This fact might have influenced overall evaluations of the exercise bouts. The scale used measured only one half of the desire/aversion continuum (i.e. aversiveness). Further, an absolute workload to achieve a heart rate of 130 bpm was selected for low-intensity exercise. Working at 130 bpm might have been considered low, moderate, or vigorous intensity exercise for participants based on their relative fitness levels. These flaws prevent one from drawing a conclusion as to whether the Peak-End rule (Kahneman et al., 1993) applies in an exercise setting. The current study therefore addressed the problems with this previous research, one of the most important of which was the method used to measure exercise intensity (Ekkekakis et al., 1999), and it also assessed the influence of the end affect on future choice.

In conclusion, the Peak-End rule and the Duration Neglect Hypothesis (Kahneman et al., 1993) have been found to be true in a number of fields, but similar research in an exercise setting is limited and largely flawed. The present study examined these well-supported hypotheses in an exercise context to determine whether an exercise bout that creates an affectively positive end influences exercise choice.

CHAPTER 3. METHODS

Participants

Participants were 27 healthy male and female adults between the ages of 18 and 35. Inclusion criteria were a Body Mass Index (BMI) of 25 or higher and being less physically active. Low physical activity was defined as engaging in less than the recommended amount of physical activity (i.e. less than 150 minutes per week of moderate intensity or less than 75 minutes of vigorous intensity) in the preceding week. The 7-day physical activity recall questionnaire was used to determine participant's activity level (see Appendix C; Sallis et al., 1985). Recruitment was done via posters, fliers and e-mails (see Appendix A) sent throughout a large university and in the community, and participants were each paid $40 for their participation. In previous studies, an effect size of 0.6 and a power level of 0.8 was used for power analysis calculations (Ekkekakis, Lind, & Vazou, 2008). As used in these previous studies, a sample size of 30 was determined. Exclusion criteria included smoking, inability to exercise, medical conditions such as diabetes, hypertension, BMI less than 25 and being younger than 18 years of age or older than 35 years of age.

Measures

Physiological measures. Body mass and body fat percentage were measured with a Bioelectrial Impedance scale (model BF-626, Tanita, Tokyo, Japan) according to standard instructions. BMI was calculated based on the participant's body mass and height. Heart rate was measured with a heart rate monitor (Polar Electro Oy, Kempele, Finland). The signals from the sensor were interfaced to the computerized metabolic analyzer. Respiratory gas exchange was measured using a metabolic measurement cart (model TrueMax 2400, ParvoMedics, Salt Lake City, UT, USA). This device was calibrated before each session for

flowmeter calibration using a 3-liter syringe. Gas calibration was also done according to the manufacturer's specification. The facemask used was a two-way, nonrebreathing valve (model 8920/30, Hans Rudolph, Kansas City, MO, USA). To prevent the escape of air from any gaps that might be present on the mask, a gel sealant was applied when needed (model 7701, Hans Rudolph)**.**

Affect. Affective experience before, during, and after exercise was assessed using the Feeling Scale (FS; Appendix F; Hardy, & Rejeski, 1989). This is a bipolar rating scale with 11 anchors ranging from -5 to +5, -5 being "Very bad,' +5 being "Very good," and 0 being "Neutral." The correlations between FS and the Valence Scale of Russell, Weiss, and Medelsohn's (1989) Affect Grid are 0.41 to 0.59 (Van Landuyt et al. 2000).

Procedures

The participants reported to the laboratory for four sessions. The second session was scheduled a week after the first session. The second, third, and the fourth sessions were scheduled approximately two days from each other. The exercise sessions were performed on a treadmill (Landice, Randolph, NJ, USA).

Peak exercise test session. The first session was an incremental maximal exercise test to volitional exhaustion to determine the ventilatory threshold (VT) and VO_2peak. During this session, the participants were familiarized to the laboratory setting and the procedure was explained. The different scales were explained to the participants and questions were answered. After they understood the procedures, the participants read and signed the informed consent form (Appendix B) approved by the university's Institutional Review Board. Height, body mass, heart rate, and blood pressure were recorded to ensure the safety

of the participants. After the collection of pre-mask data, participants wore a nasal and mouth breathing mask. To ensure that the metabolic system was working properly, two minutes of resting data were collected. The workload was set at 2.5 mph for the first 3 minutes which was the warm-up period. After the warm-up, the workload was increased by 1 mph or 1% grade every other minute. The bout continued until the participant reached volitional exhaustion and terminated the test. The attainment of peak oxygen uptake was verified by reaching an RER greater than 1.1, maximal age-predicted heart rate or a plateau in oxygen consumption with increasing workloads. After this session, VT was determined. In line with previous research (e.g., Gaskill, Ruby, Walker, Sanchez, Serfass, & Leon, 2001), three methods were used to determine VT: the V-slope method, the method of ventilator equivalents, and the excess CO_2 method. VT was determined based on consensus from two of three researchers experienced with these methodologies.

Low End and High End sessions. A computer-generated randomization list was used to determine the order of sessions. Due to findings that exercise above the VT causes a decline in affective responses (Ekkekakis et al., 2006; Ekkekakis et al., 2008), the workload was set at 10% of VO_2peak above VT (10% >VT) in these two exercise sessions. The workload was gradually increased to reach 10% above VT at the end of the first 5 minutes of warm-up. This workload was maintained at 10%>VT for 15 minutes. Beyond VT, there is a shift that results in VO_2 uptake increasing linearly with time as opposed to reaching a steady-state. Therefore, this protocol was designed to cause an increase in oxygen uptake throughout the 20-minute period resulting in a peak negative affective experience at the end (based upon the inverse relationship between exercise intensity and affect found in previous research: e.g., Hall et al.,

2002a; Welch et al., 2007). In the High End trial, the participant stopped exercising immediately after exercising at 10%>VT for 20 minutes. In the Low End trial, there was a 5-minute low intensity (i.e. at 2.5 miles per hour, 0% grade) period of exercise added to the end of the bout, which was designed to induce a positive affective end. At the outset of each of these sessions, participants were told that they will be exercising between 20 and 30 minutes at a predetermined intensity and were asked to continue at a pace that was comfortable for them. Before the start of exercise, their wristwatches were removed and they were not aware of the elapsed time. FS response was recorded before exercise, every 2:30 minutes during both sessions, and at 0, 5 and 10 minutes after exercise. At the end of each exercise session, overall evaluation of FS for the session as a whole was recorded.

Choice session. In the fourth session deception was used to discover the true exercise choice: participants believed that they would exercise on the treadmill one more time. The participant was given a written question (see Appendix E): "You have performed two exercise bouts during your last two trials here. For today's session, we would like you to choose one of those two exercise bouts to perform again. The exercise you perform today will be based solely on the choice you make and will be exactly the same as the session you choose. So, which exercise session would you like to repeat?" In other words, they were given a choice to select either the second or the third sessions; namely either to exercise at 10% above VT for 20 minutes or 10% above VT for 20 minutes followed by 5 minutes of low-intensity exercise. To discover the reason for selection, an open-ended question, "I chose this session because…" was given. After they chose an exercise session, they were not required to

perform the activity but instead were given a debriefing about the purpose of the study, the need for deception, and offered an individualized exercise prescription.

Statistical analyses

Firstly, t-tests were performed to compare the baseline (i.e. pre-exercise) FS scores between the two sessions. This was done to ensure that there were no baseline differences in affect scores. To compare affective scores before and after exercise, a 2 (Trial) x 5 (Time) Analysis of variance (ANOVA) of FS (measured Pre-mask, Post-mask, Post-0, Post-5, Post-10) was performed. To determine the changes in VO_2 during exercise, a 2 (Trial) x 8 (Time) repeated measures ANOVA was performed on FS data during exercise. To determine whether participants' affect during the first 20 minutes of the two exercise conditions were similar, a 2 x 8 (Trial x Time) repeated measures ANOVA was performed on FS data (measured at 2:30, 5:00, 7:30, 10:00, 12:30, 15:00, 17:30 and 20:00 minutes) with exercise condition as the between-subjects factor and time as the within-subjects factor. To determine the effects of low intensity exercise on affect, a 1 (Low End Trial) x 3 (Time) repeated measures ANOVA was conducted. Follow-up analyses included one-way repeated measures ANOVA with pairwise comparisons (using Bonferroni corrections for multiple comparisons). Finally, a Chi-square test was performed to determine whether the proportion of participants who selected one exercise bout over the other was significant. If any of the demographic variables were found to correlate with affect, they might have acted as potential confounders of choice of exercise. Therefore, the baseline demographic variables were examined as potential influencers of end-exercise affect using Pearson correlations.

CHAPTER 4. RESULTS

A total of 309 individuals responded to the initial community-wide advertisement and 45 individuals were eligible to participate in this study. From this, 10 individuals indicated a lack of interest to participate in the study upon reading the informed consent document. Finally, 35 individuals were recruited as participants. Eight participants dropped out of the study due to: time pressures with job/classes (n=5), personal situations (n=1), and lack of interest (n=2). Therefore, results are presented for 27 participants (13 women and 14 men). Demographics are shown in Table 1. The participants reported participating in 60±25 minutes of moderate or 20±15 minutes of vigorous physical activities per week. The average VO_2 peak was 29.67 $ml \cdot kg \cdot min^{-1}$ and 30 $ml \cdot kg \cdot min^{-1}$ for females and males, respectively. When compared to the normative data for 20-29 year olds, these values fall at the 10^{th} and 5^{th} percentile for females and males respectively. Both of these are classified between "Very poor" and "Poor" (American College of Sports Medicine, 2010).

Table 1: Baseline Demographics

Baseline demographics	**Mean±SD**
Age (years)	26±4.6
Height (cm)	170±8.8
Body mass (kg)	81±12.7
Body Mass Index ($kg \cdot m^{-2}$)	28±2.4
Body fat (%)	30±7.7
VO_2 peak ($ml \cdot kg \cdot min^{-1}$)	30±7.5
VT ($ml \cdot kg \cdot min^{-1}$)	17±4.0
VT as a % of VO_2 peak ($ml \cdot kg \cdot min^{-1}$)	58±8.1

Intensity and affect manipulations

Participants' mean VO_2 at 10% >VT was 17.40 $ml \cdot kg \cdot min^{-1}$. A 2 (Trial) by 8 (Time) repeated-measures ANOVA on VO_2 showed a significant time main effect (see Figure 1),

$F(2.45, 63.62) = 57.93$, $p < 0.05$, $\eta^2 = .69$ but no trial main effect, $F(1, 26) = .19$, $p = 0.66$, $\eta^2 = .01$. An interaction between time and trial was not found, $F(4.3, 112.14) = .62$, $p = 0.66$, $\eta^2 = .02$.

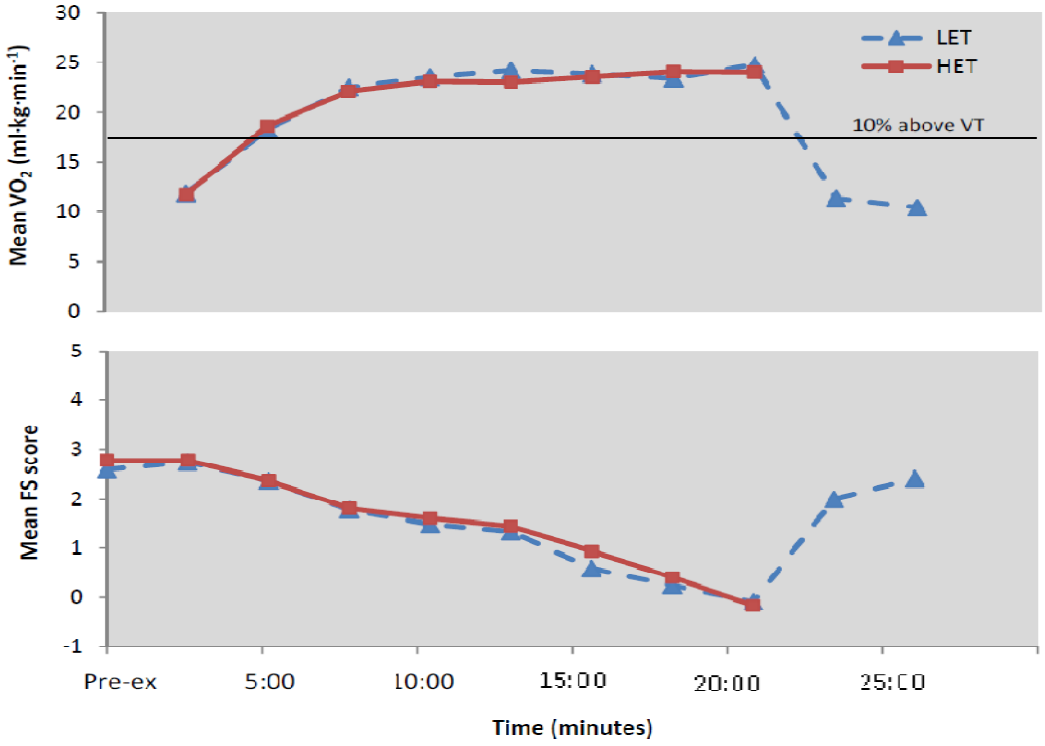

Figure 1: Mean affect (FS scores) and mean VO_2 during 'Low End' and 'High End' exercise

FS at baseline (pre-exercise) was not significantly different between the two exercise sessions (t= .895, p = 0.38; Figure 1). Additionally, a paired t-test showed there was no significant difference between FS scores before and after participants were fitted with the mask in either sessions; the HET, t= 1.16, p = 0 .26, and the LET sessions, t= 0.00, p = 1.00.

A 2 (Trial) x 5 (Time) repeated-measures ANOVA on FS before and after exercise revealed a significant time main effect, $F(1, 24) = 5.37$, $p < .05$, $\eta^2 = .18$ and a significant trial main effect, $F(1.33, 31.81) = 4.17$, $p < .05$, $\eta^2 = .15$. Also, there was a significant interaction

between time and trial, $F(1.76, 42.24) = 9.84$, $p < .05$, $\eta^2 = .29$. Follow-up analyses from the HET trial revealed significant increase from Post-0 to Post-5 ($p < .05$) and Post-0 to Post-10 ($p < .05$) and no other significant changes. Additionally, follow-up analyses of the LET trial showed no significant change in FS from pre-exercise to any post-exercise time points. However, it should be noted that there was a trend towards significance from Post-0 to Post-10 ($p = .05$; see Table 2).

Table 2: Mean FS (affect) scores (SD) before and after a 20-minute bout of high-intensity exercise (HET) and an identical exercise bout with an additional 5-minute low-intensity end (LET)

Time (minutes)	Pre-mask	Post-mask	Post-0	Post-5	Post-10
HET	2.76	2.60	1.28	2.684	3.12
	(1.39)	(1.47)	(2.26)	(1.55)	(1.26)
LET	2.52	2.56	2.72	3.08	3.36
	(1.39)	(1.29)	(1.51)	(1.29)	(1.15)

Results of the FS data during exercise showed that there was a significant main effect for time, $F(2.07, 53.72) = 38.35$, $p = < 0.05$ $\eta^2 = .596$, but no condition main effect or Time x Trial interaction. Therefore, FS scores were significantly more negative/less positive at minute 20 when compared to minute 2:30 in both exercise bouts (see Table 3).

A one-way repeated measures ANOVA was conducted to compare the FS scores of the end of the high intensity period (minute 20:00) and during the low intensity period within the Low End Trial (22:30 and 25:00). There was a significant main effect for time, $F(1.40, 36.49) = 51.46$, $p < 0.05$ $\eta^2 = .664$**.** The trend portrayed in Table 3 and Figure 1 show that affect became progressively more positive throughout this 5 minute period. Therefore, adding a short period of reduced intensity in the low-end condition was successful in inducing a peak positive affect at the end of that exercise bout.

Table 3: Mean FS (affect) scores (SD) during a 20-minute bout of high-intensity exercise (HET) and an identical exercise bout with an additional 5-minute low-intensity end (LET)

Time (min)	**2:30**	**5:00**	**7:30**	**10:00**	**12:30**	**15:00**	**17:30**	**20:00**	**22:30**	**25:00**
HET	2.74 (1.29)	2.37 (1.24)	1.78 (1.37)	1.48 (1.48)	1.33 (1.66)	0.59 (1.87)	0.24 (2.06)	-0.09 (2.20)		
LET	2.78 (1.19)	2.37 (1.11)	1.81 (1.24)	1.61 (1.21)	1.44 (1.40)	0.93 (1.49)	0.41 (1.74)	-0.19 (2.02)	2.00 (2.08)	2.41 (1.76)

Choice of exercise trial

The results of the Chi-square analysis indicated there was no significant difference in the proportion of individuals who chose one exercise over the other session, X^2 (1, n=27) = 3.00, p = 0.083, but an emerging trend was evidenced. A total of 18 out of 27 participants chose the longer session which included the affectively positive end (Figure 2). From the results, we can conclude that there is a 2.03:1 trend for participants to select an exercise that ended pleasantly.

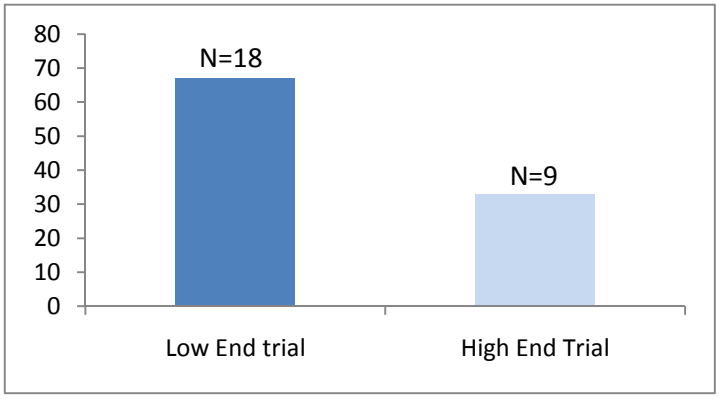

Figure 2: Percentage of participants who chose to repeat one of the two different exercises

Effect of demographic variables on choice of exercise

There was a significant correlation between BMI and affect measured at the end of exercise, as well as BMI and affect measured immediately after exercise in the Low End trial (r = -0.391; p < .05 and r = -0.587; p < .05, respectively). As shown on Table 4, no other

demographic variables were correlated with baseline affect, end of exercise affect, affect measured after exercise, or overall evaluation of affect in either condition.

Table 4: Pearson coefficients between affect and demographic variables

	High End affect				Low End affect			
Demographic Variables	Pre-exercise	End of exercise	Post-exercise	Overall	Pre-exercise	End of exercise	Post-exercise	Overall
Gender	0.119	-0.152	-0.211	-0.235	0.094	0.184	0.287	0.1
BMI	0.109	-0.126	-0.291	-0.149	-0.129	**-0.391***	**-0.587***	-0.165
Order of trials	0.12	0.254	0.293	0.017	-0.195	0.197	0.322	0.238
VO_2 peak ($ml \cdot kg \cdot min^{-1}$)	0.02	0.145	0.223	0.185	-0.092	0.33	0.193	0.073

*p < .05 level (2-tailed)

Reasons for choice

Of the 18 participants who chose LET, 12 participants reported they picked the session for psychological reasons (e.g., it was more enjoyable compared to the HET, did not feel as hard, felt satisfied after the session); of this two participants reported that although the session was longer it was easier. Five participants reported that they did not specifically remember the difference between the two sessions.

Table 5. Reason for choice of exercise

	# of participants* [LET+HET=Total]
Psychological reasons	**13+3=15**
"More enjoyable/less boring"	7+0=7
"Exertion, felt hard/easy"	4+2=5
"More satisfied"	2+0=2
"Longer and bored"	0+1=1
Physiological reasons ("less leg pain," "more on par with a usual exercise bout")	**6+3=9**
Not sure about differences	**5+0=5**

(* Numbers will not total to 27 because some [N=2] participants gave more than one reason for choice)

Physiological reasons such as “less leg pain”, “more on par with a usual exercise bout” were reported as reasons for selection by 9 participants (3 chose HET). Two participants, of the 9 who chose HET, reported the trial was harder but still they would like to repeat that bout. One participant who chose the HET commented that the other session was long and boring (see Table 5).

CHAPTER 5. DISCUSSION

The Peak-End theory (Kahneman et al., 1993) is a widely supported theory in the general psychology literature. The purpose of the current study was to test this theory in an exercise context by investigating the influence of a positive peak and end affective experience during exercise on future selection of exercise. This is one of the first studies in the exercise psychology literature that examined the influence of affective experience during exercise on subsequent exercise choice.

One objective of this study was to investigate whether adding a reduced intensity period at the end of an exercise bout resulted in a positive end affect. The results show that the target VO_2 was achieved during the initial five minutes of exercise (see Figure 1). Due to the physiological drift in VO_2 over time, the VO_2 at 20 minutes was significantly higher than the target VO_2. As shown on Figure 1, during the high intensity portion of the two exercise bouts, VO_2 uptake increased. During the low intensity portion of the Low End Trial, the VO_2 uptake decreased indicating successful VO_2 manipulations.

As proposed, the manipulation of exercise intensity was successful in inducing differences in affective responses at the end of the two exercise bouts. The results show that exercising at 10%>VT for 20 minutes (HET) resulted in a significantly more negative affective experience at the end of the bout compared to the beginning. On the other hand, exercising at 10%>VT for 20 minutes followed by a 5 minute low intensity period added to the end of the bout (LET) resulted in a similarly negative affective experience at 20 minutes, but this was followed by positive affective experience during the last 5 minutes (Figure 1).

These findings are in line with other similar research (Brewer et al., 2000; Redelmeier et al., 1996) and extend previous research findings by supporting the effects of exercise intensity on the pleasure-displeasure continuum (Brewer et al., 2000; Kilpatrick et al., 2003). Brewer et al. (2000) examined the influence of reduced intensity on perceived aversiveness to exercise. Results of this research are also in concordance with the results obtained when three different end paces of cycle ergometry (high intensity end, moderate intensity end and low intensity end) were examined (Kilpatrick et al., 2003) where participants reported reduced post-exercise exertion with a low intensity end. The low intensity end might allow the participant to gradually regain physiologic equilibrium and also feel better (e.g., Cabanac, 2006; Petruzzello, Jones, & Tate, 1997).

In the current study, the affect scores after exercise did not improve significantly from baseline affect. These results are different from previous research findings involving normal-weight individuals where the post-exercise affect showed a significant improvement from baseline (Hall et al., 2002; Ekkekakis, 2005). However, results from Welch et al. (2007) indicate a somewhat delayed improvement in affect after exercise among inactive participants. In this study, affect scores 10 minutes after high intensity exercise was significantly better than pre-exercise affect, but at 0 and 5 minutes after exercise no significant improvement was seen (Welch et al., 2007). Inactive, overweight individuals might need a longer recovery time than active, normal-weight individuals to obtain affective benefits. Unfortunately, in the present study, affect was measured only up to 10 minutes post-exercise. Therefore, research that measures affect for a longer duration after exercise is needed to ascertain this.

Further, the current results show that in the exercise that ended with a high intensity (HET), there was a significant improvement in affect 5 and 10 minutes after exercise compared to immediately after exercise (see Table 2). On the other hand, in the exercise that ended with a low intensity (LET), though there was a trend towards significance the affect scores did not show a statistically significant improvement. These post-exercise results might be explained based on the affective experiences measured towards the end of exercise. In the LET trial, participants experienced a more positive affect towards the end of exercise (i.e. Minute 25; see Table 1). Whereas, in the HET trial participants' affect towards the end of exercise was less positive and became more positive only after they stopped exercising (i.e. post-exercise; see Table 2). These results indicate a slightly delayed rebound toward more positive affect after exercise that ends at a high intensity.

The second purpose of this study was to identify whether participants would choose to repeat an exercise bout that ended with a positive affective experience, even if it was longer. The results provide evidence that peak affective experiences towards the end of exercise influence the choice of exercise. More specifically, participants were twice as likely to choose to repeat the exercise bout that ended positively over the one that ended negatively, even though it was longer and involved more work overall. The simplest explanation for the current findings is the Peak-End (Kahneman et al., 1993) and duration neglect hypotheses (Kahneman et al., 1993). In line with our hypotheses, participants' choice was characterized by the Duration Neglect and Peak and End evaluation of affect. The reason for the statistically non-significant Chi-square results may be attributed to type II error (i.e., false

acceptance of the null hypothesis because there was not a large enough sample size to find a statistically significant result).

The finding that duration neglect and the peak and end rule (Kahneman et al., 1993) were maintained in the current research is similar to previous work from other fields (Baumgartner et al., 1997; Diener et al., 2001; Do et al., 2008; Hands et al., 2001; Kahneman et al., 1997; Langer, Sarin, & Weber, 2005; Redelmeier et al., 1996; Ross et al., 1991; Rozin et al., 2004). For example, Redelmeier et al. (2003) found that the return rates for repeat medical procedures were higher for a longer procedure with less painful final moments when compared to a procedure that ended with higher pain levels. The cold immersion experiment (Kahneman et al., 1993) showed that 69% of participants preferred to immerse their hand in cold water for 90 seconds (with the final 30-second period involving less discomfort) over 60 seconds even though it was longer and more overall pain. In the present study, an exercise that ended with a positive affective experience was considered as overall more pleasant than an exercise that ended with a negative affect.

This study examined the relationship between exercise intensity and affective responses from a decision-making standpoint. Affective responses to exercise during and immediately after exercise have been examined by others (e.g., Ekkekakis et al., 2008). However, when the question of repeating an exercise arose, participants did not appear to evaluate each moment of the exercise equally. There was a violation of temporal monotonicity (Kahneman et al., 1993) – adding moments of positive end affect increased the preference for the longer exercise session though the rest of the exercise bout was experienced exactly the same as the comparative bout, and the added period of exercise

increased the overall work done. The affective experiences from the start of exercise to minute-20 were equal between the two conditions; the only difference in affective experience during exercise between the two exercise sessions of this experiment was during the 5-minute low intensity. Hence, one explanation for these results might be that the positive end induced a positive memory, and individuals tend to repeat an activity that formed a positive memory (Ariely et al., 2000; Ariely et al., 2003). In addition, humans are conditioned to avoid activities that have less favorable memories (Kahneman et al., 1999). With the large number of drop outs of exercise programs (Dishman et al., 1997; Pate et al., 1995), it is important to consider whether certain moments of the affective experience of exercise appear to determine choice.

Further support for this deduction comes from participants' answers to the open-ended question about why a particular choice was made. The majority of individuals (14/27; 12 chose LET and 2 chose HET) stated the reason for their choice as more pleasant or less difficult. Five out of eighteen (who chose the LET) answered that they did not remember the differences between the two trials. This suggests that the evaluated affective memory might not rely on conscious processing of information; the evaluative memory might be fallible and guide individuals to do more overall work. On the other hand, participants (n=2/9) who chose the shorter bout chose this session because they felt it was "hard." For example, one participant reported, "I felt like I worked harder and I felt better after it." The results suggest that the recall of exercise behavior occurs in a complex way that is not based on evaluation of single moments while involved in the exercise. There is a wide inter-individual variability in the preference for strenuous exercise, in that some individuals tend to like more vigorous

exercise (Ekkekakis et al., 2005a; Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000). Given that a third (n=9/27) of the participants in this study chose HET, to better understand the psychological processes during exercise selection these individual differences have to be addressed. It is also important to note that some participants (n=2) in this study recorded that they identified the differences in duration between the two sessions, but chose the longer session in spite of it being longer. One participant reported, "I felt the session lasted about the same amount of time or longer, but was not as fatigued afterwards." Memories, and not real-time experiences, appeared to form the basis of this exercisers' choice.

Practical applications

The findings from the current study have three important implications. One major finding from the present study is that the pleasantness during exercise can be increased by having the ending moments of an exercise extended to include a positive end. In short, ending an exercise session positively may increase adherence and in turn increase exercise participation. Current exercise recommendations do not include clear-cut guidelines about increasing the pleasantness of exercise. With the current research findings, and strong links between exercise adherence and enjoyment (Wankel, 1993), exercise prescriptions could be tailored to increase the positivity during exercising.

Secondly, one major goal of exercise prescriptions is to reduce the risk factors for cardiovascular disease (CVD). Higher exercise intensities are associated with higher CV fitness benefits and reduced CVD risks (Swain & Franklin, 2006). Inactive and overweight participants reach their goals in weight loss and other health benefits quicker by exercising at vigorous intensity rather than by exercising at low intensity (Slentz, Duscha, Johnson,

Ketchum, Aiken, Samsa et al., 2004). On the other hand, overweight and obese individuals tend to dislike exercising at higher intensities (Ekkekakis et al., 2006). An intensity even 10% above VT has been found to show displeasure responses (Ekkekakis et al., 2008). Our findings confirm these results in overweight low-active individuals. However, the present investigation also provides evidence that the aversive effects of exercising at higher intensity (10% above VT) might not be an important factor for selection of exercise in overweight individuals provided the end portion is pleasant. The experience of end portion of an exercise bout appears to have a larger input during decision-making. Hence, adjusting the prescription to include a positive end might indirectly hasten the CV fitness benefits by increasing adherence.

Finally, duration neglect has important implications. By participating in a longer exercise that ends with a positive affective experience, individuals tend to spend more calories and also have a positive affective involvement in the exercise experience. Therefore, for those individuals interested in losing weight but find it difficult to adhere to an exercise program, ending their workout with a reduced intensity (thereby positive end affect) might result in them choosing this exercise over others, and by doing so perform more overall exercise with increased adherence.

Limitations and future directions

The current study showed that a positive affect-inducing event (i.e. reduced exercise intensity at the end of the bout) during exercise was an important indicator in choice of exercise pattern. However, there might be various other factors that played a role in decision-making. For example, we examined only the effects of affective valence during exercise on

choice. To obtain a better understanding of the impact of exercise experience on choice, future studies have to examine the impact of other exercise-induced responses such as perceived activation and perceived exertion. One other limitation of the present study is that the exercise choice was made after acute exercise. In reality, when individuals are involved in an exercise program they may consider each bout of exercise as a continuation ofthe previous session. The Peak-End rule (Kahneman et al., 1993) has not been found to apply to continuing episodes (Fredrickson et al., 1993) of volitional behavior. Thus, future research should develop intervention studies that address these factors.

In addition, duration may not always be neglected. This study involved a very small difference in exercise duration between the two exercise bouts. The paradoxical effect of adding additional time to an exercise bout and improving the overall pleasantness might not apply to very short or too long exercise bouts. Also, the effect of intensity might be less pronounced in experiences which formulate an especially positive or especially negative affect in particularly low or particularly high intensities of exercise. Future research should examine the effects of the Peak-End rule (Kahneman et al., 1993) at various intensities and durations.

CHAPTER 6. CONCLUSION

In conclusion, our research findings extend the Peak-End (Kahneman et al., 1993) and duration neglect rules to decision-making of overweight inactive exercisers. That is, with everything else being equal between two exercise sessions, adding a short period of pleasantness to the final moments of an unpleasant exercise bout doubled the participants' chances of repeating the exercise. The application of this theory suggests that to increase the likelihood that participants will repeat the exercise in future; exercise professionals should consider adding a low intensity period at the end of exercise when it is necessary to make high intensity exercise prescriptions.

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APPENDIX A: RECRUITMENT E-MAIL DOCUMENTS

Recruitment e-mail

Research Participants Needed. Are you overweight/obese? Are you planning on starting an exercise program?

We are looking for participants 18-30 year old, inactive men/women are needed to participate in a research study investigating the psychological and physiological effects of exercise. The study will involve four visits to the exercise psychology laboratory in the Forker Building at Iowa State University. As a result of your participation, you will find out your cardiovascular fitness level and will have the opportunity to receive an exercise prescription based on your personal physical and psychological responses to exercise. Compensation ($40) will be provided for your participation.

For more information about this study please contact:

Shenbaga SoundaraPandian	shenbaga@iastate.edu	(515)-294-8900
Dr. Amy Welch	amywelch@iastate.edu	(515)-294-8100

Follow-up second e-mail

Hi (name of participant),

Thank you for showing interest in participating in our exercise study. This e. mail is to give you more information about the study.

There will be four sessions in this study. Each one will last from 45 – 90 minutes from the time that you enter till you leave, and you will be asked to exercise on a recumbent bike during each visit.

The attached document has detailed information about the study. Please read it and get back to me if you have any questions or concerns. If you would like to participate, please fill the form attached as a second document with this e. mail and send it back to shenbaga@iastate.edu. You can also call me at 294-**5418** to fix an appointment. Thank you.

Scheduling e-mail

Hi (name of participant),

Thank you for your reply. Your first session has been scheduled on _____ at _____ am/pm. I will meet you at the front door a few minutes before the scheduled time. If you have any questions please call me (515-294-5418) or e. mail me (shenbaga@iastate.edu).

A few reminders: Do NOT smoke, drink caffeinated beverages, exercise or eat a heavy meal for 2 hours before testing time. Come in comfortable clothes/shoes to exercise in. Bring reading glasses if you need them for the surveys.

Thank you.

APPENDIX B: INFORMED CONSENT DOCUMENT

INFORMED CONSENT DOCUMENT

Title of Study: Psychological and physiological responses to graded treadmill exercise.
Investigators:

Amy Welch, Ph.D.
Assistant Professor
251 Forker Building
Department of Kinesiology
Iowa State University
Ames, IA 50011-1160
Tel. (515) 294-8042
E-mail: amywelch@iastate.edu

Panteleimon Ekkekakis, Ph.D.*
Associate Professor
235 Forker Building
Department of Kinesiology
Iowa State University
Ames, IA 50011-1160
Tel. (515) 294-8766
E-mail: ekkekaki@iastate.edu

Shenbaga SoundaraPandian, M.S.**

*Co-Principal Investigators

** Research assistant who will conduct the study and obtain informed consent

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

INTRODUCTION

The purpose of this study is to examine physiological and psychological responses to bouts of aerobic exercise. You are being invited to participate in this study because we are investigating specific physiological and psychological responses in a representative sample from a young, healthy adult (ages 18 to 35 years old) population.

DESCRIPTION OF PROCEDURES

If you agree to participate in this study, your participation will last for the duration of four separate visits to the exercise psychology laboratory (0164M Forker Building on the ISU campus). During the **first visit**, you will be familiarized with the instruments and equipment used in the data collection process and perform a graded (incremental) exercise test on a treadmill. This is a test that determines the ability of your body to take oxygen from the air, deliver it to your working muscles and utilize the oxygen in the muscle. The speed and grade of the treadmill will be gradually increased until you choose to discontinue the test. You will be able to terminate the test yourself when you feel that you have reached your limit. This test is expected to last between 5 and 15 minutes in addition to warm-up and cool-

down. Following this test, you will be asked to complete a battery of questionnaires. During the **second, third, and fourth visits**, you will be asked to perform an exercise test on a treadmill. Following this test, you will be asked to complete a battery of questionnaires. Before the test, the researchers will attach a breathing mask on your face, so that they can collect and analyze the gases that you expire and, thus, determine how much oxygen you are using. A heart rate monitor will be placed around your chest to monitor heart function during the test. Upon completion of the test, you will rest comfortably for 30 minutes. The order in which the second, third and fourth visits take place will be randomized.

During visits 2-4, the researchers will ask you to indicate how you feel on some simple ratings scales. **You may skip any question that you do not wish to answer or that makes you feel uncomfortable.** All the visits are expected to last approximately 60 to 90 minutes.

RISKS

Participating in vigorous exercise may carry potential dangers, such as cardiovascular problems or musculoskeletal injuries. Although it is not possible to predict all such occurrences, the researchers try to minimize the risk. Other possible adverse effects include: (a) Muscle soreness or fatigue during or following the exercise sessions. These effects should not last more than a couple of days. You have the right to request that another exercise session not be scheduled until these symptoms have passed, (b) Discomfort associated with wearing the face mask that will be used for the collection of expired gases. You will be able to try this mask on to see whether you feel comfortable wearing it. The researchers will assist you in adjusting the mask so that it is as comfortable as possible, but you have the right to withdraw your consent if you feel discomfort or resistance in your breathing. Please note that all materials that you will come in contact with (including the face mask) will be either single-use or thoroughly washed and disinfected.

BENEFITS

If you decide to participate in this study there will be a direct benefit to you: you will receive a free fitness assessment and specific, personalized physical activity recommendations based on your fitness assessment. It is also hoped that the information gained in this study will benefit society by providing valuable information on the types and amounts of physical activity that are likely to increase people's motivation to remain active over the long haul.

COSTS AND COMPENSATION

You will not have any costs from participating in this study. However, you may receive monetary compensation, up to $40.00, for your involvement. The money will be distributed in the following manner: $5.00 for completion of trial 1; $10.00 for completion of trial 2; $10.00 for completion of trial 3; and $15.00 for completion of trial 4. In order to

receive your honoraria, you must complete the Iowa State University Research Participant Receipt Form (RPRF).

PARTICIPANT RIGHTS

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled.

RESEARCH INJURY

Emergency treatment of any injuries that may occur as a direct result of participation in this research is available at the Iowa State University Thomas B. Thielen Student Health Center, and/or referred to Mary Greeley Medical Center or another physician or medical facility at the location of the research activity. Compensation for any injuries will be paid if it is determined under the Iowa Tort Claims Act, Chapter 669 Iowa Code. Claims for compensation should be submitted on approved forms to the State Appeals Board and are available from the Iowa State University Office of Risk Management and Insurance.

CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies (the National Institutes of Health) and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, your name and other identifying information will be permanently erased once the collected data have been tabulated and entered in a computer for statistical analysis. Thus, there will be no traceable connection between your name and your data. Until the data are tabulated, your records will be kept in a room that will be locked at all times and only the researchers will have access to it. If the results are published, your identity will remain confidential.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study. For further information about the study, contact Dr. Amy Welch (251 Forker Building, 515-294-8042, amywelch@iastate.edu) or Ms. Shenbaga SoundaraPandian (164M Forker Building, 515-294-5418, shenbaga@iastate.edu). If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director, Office of Research Assurances, (515) 294-3115, 1138 Pearson Hall, Ames, IA 50011.

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PARTICIPANT SIGNATURE

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered. You will receive a copy of the written informed consent prior to your participation in the study.

Participant's Name (printed) _____

_____ _____

(Participant's Signature) (Date)

INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agreed to participate.

_____ _____

(Signature of Person Obtaining Informed Consent) (Date)

APPENDIX C: PRE-PARTICIPATION SCREENING FORM

Demographic Information

Name: _____ **Gender**: Male ☐ Female ☐

Age:_____ **Height:** _____ **Weight:** _____

Birthday: _____/_____/_____ **Phone**: (515) -

E-mail address: _____

Par- Q & You

Yes	No	
☐	☐	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2. Do you feel pain in your chest when you do physical activity?
☐	☐	3. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6. Is your doctor currently prescribing drugs (for example, water pills) for you blood pressure or heart condition?
☐	☐	7. Do you know of any other reason why you should not do physical activity?
☐	☐	8. Have you ever been diagnosed with a medical condition that currently is under control (e.g., high blood pressure)? If yes, describe_____
☐	☐	9. Were you prescribed any medication for this past medical diagnosis? If yes, describe_____

Risk Factors

1. Smoking	Yes	No		
Do you smoke	☐	☐		
Cigarettes	☐	☐	How many per day? ____	How many years? ___
Cigar	☐	☐	How many per day? ____	How many years? ___
Pipe	☐	☐	How many times per day?__	How many years?____

HAVE YOU HAD A RECENT MEDICAL CHECK-UP?

It was explained to me that participation in bouts of vigorous exercise might be harmful to people with certain medical conditions. I hereby confirm that I have had a physical examination within the last 12 months, which showed that I am in perfect health. I also confirm that, to the best of my knowledge, I have no history of any cardiovascular, respiratory, musculoskeletal, or mental conditions. Finally, at this time, I am not suffering from any injuries or other ailments and I am under no medication.

_____ _____

(**Signature**) (**Date**)

Stages of Change Questionnaire

	True	False
1. I currently do not exercise	☐	☐
2. I intend to exercise in the next 6 months	☐	☐
3. I currently exercise regularly*	☐	☐
4. I have exercised regularly* for the past 6 months	☐	☐
5. I have exercised regularly* in the past for at least 3 months, but I am not doing so current	☐	☐

7-Day Physical Activity Recall Interview Questionnaire

Now we would like to know about your physical activity during the past 7 days. And also let me ask you about your sleep habits.

1. On the average, how many hours did you sleep each night during the last **5** weekday nights (Sunday through Thursday)? (Record to the nearest quarter-hour)

   ☐☐ ☐ Hours

2. On the average, how many hours did you sleep each night **last Friday and Saturday** nights?

   ☐☐ ☐ Hours

3. Now about your physical activities, let's first consider **moderate** activities. What activities did you do and how many total hours did you spend during the last **5** weekdays doing these moderate activities or others like them? Please tell me to the nearest half-hour.

   ☐☐ ☐ Hours

4. **Last Saturday and Sunday**, how many hours did you spend on **moderate** activities and what did you do? (Probe: Can you think of any other sport, job, or household activities that would fit into this category?)

   ☐☐ ☐ Hours

5. Now let's look at **hard** activities. What activities did you do and how many total hours did you spend during the last **5** weekdays doing these hard activities or others like them? Please tell me to the nearest half-hour.

   ☐☐ ☐ Hours

6. **Last Saturday and Sunday**, how many hours did you spend on **hard** activities and what did you do? (Probe: Can you think of any other sport, job, or household activities that would fit into this category?)

   ☐☐ ☐ Hours

7. Now let's look at **very hard** activities. What activities did you do and how many total hours did you spend during the last **5** weekdays doing these hard activities or others like them? Please tell me to the nearest half-hour.

   ☐☐ ☐ Hours

8. **Last Saturday and Sunday**, how many hours did you spend on **very hard** activities and what did you do? (Probe: Can you think of any other sport, job, or household activities that would fit into this category?)

   ☐☐ ☐ Hours

Scheduling

Your first trial is scheduled for: _____/_____/_____

Trial 2: _____/_____/_____

Trial 3: _____/_____/_____

Reminders for participants:

1. Do **NOT** smoke, drink caffeinated beverages, exercise or eat a heavy meal for 2 hours before testing time.
2. Come in **comfortable** clothes/shoes to exercise in.
3. Bring reading **glasses** if you need them for the surveys.

APPENDIX D: DATA COLLECTION SHEETS

Trial 1 Investigation of Physiological and Psychological Responses: **IET Trial**

Pre-Mask Data: FS_____ FAS_____ AD-ACL_____ Pre-SE____ Mask

Anthropometric Data: *Resting BP*____/____ *Resting HR*____ Ht: _____ *Wt*____ (kg)

Body Fat%: _____ BMI: _____ *Monitor*___

Post-Mask Data: FS_____ FAS_____ AD-ACL_____

2-min Resting Data period: Start Metabolic Cart recording

3-min Warm Up (2:45 min): **HR**____ **S** 2.5 mph **G** 0% grade **RPE**____ **FS**____ **FAS**____

3:45	M1:	HR_____	RPE____	FS_____	FAS____	S___	G:___
4:45	M2:	HR_____	RPE____	FS_____	FAS____	S___	G:___
5:45	M3:	HR_____	RPE____	FS_____	FAS____	S___	G:___
6:45	M4:	HR_____	RPE____	FS_____	FAS____	S___	G:___
7:45	M5:	HR_____	RPE____	FS_____	FAS____	S___	G:___
8:45	M6:	HR_____	RPE____	FS_____	FAS____	S___	G:___
9:45	M7:	HR_____	RPE____	FS_____	FAS____	S___	G:___
10:45	M8:	HR_____	RPE____	FS_____	FAS____	S___	G:___

Post-Exercise: SaO_2_____ HR_____ FS_____ FAS_____

5-min. Cool-down ride @ 2.5 mph

Post-CD: SaO_2_____ HR_____ FS_____ FAS_____ AD-ACL_____ PACES _____

****At the end of cool down, remove facemask and shut off monitor****

10-Min Recovery: FS_____ FAS_____ AD-ACL_____ HR_____ SaO_2____

20-Min Recovery: FS_____ FAS_____ AD-ACL_____ HR_____ SaO_2____

Trial

Investigation of Physiological and Psychological Responses: **Constant Trial**

Pre-Mask Data: FS _____ FAS _____ AD-ACL_____ Pre-SE_____

Anthropometric Data: *Resting BP*_____/_____ *Resting HR*_____ *Wt*_____ (kg) HR *Monitor*___

2-min Resting Data period: Start Metabolic Cart recording

Workload: S: _____ G: _____

Check whether workload matches target VO2

Post-mask Data: FS _____ FAS _____ AD-ACL _____

2:15	M3:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
4:45	M6:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
7:15	M9:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
9:45	M12:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
12:15	M15:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
14:45	M12:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
17:15	M15:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
19:45	M12:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___

NO COOL-DOWN

****At the end, remove facemask and shut off monitor****

Post-Exercise: FS_____ FAS_____ AD-ACL_____ PACES _____

5-Min Recovery: FS_____ FAS_____

10-Min Recovery: FS_____ FAS_____

15-Min Recovery: FS_____ FAS_____ AD-ACL_____

Trial

Investigation of Physiological and Psychological Responses: **Low End Trial**

Pre-Mask Data: FS_____ FAS_____ AD-ACL_____ Pre-SE_____

*Resting BP*_____/_____ *Resting HR*_____ *Wt*_____ (kg) *Monitor*___

Start Metabolic Cart recording

Check 2-mins to see whether workload matches target VO2

Post-Mask Data: FS_____ FAS_____ AD-ACL_____

Exercise Workload: S = _____ mph G = ___ %

2:15	M3:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
4:45	M6:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
7:15	M9:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
9:45	M12:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
12:15	M15:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
14:45	M12:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
17:15	M15:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
19:45	M12:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___

5-min. Cool-down ride @ 50% of max below VT

22:15	M16:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___
24:45	M17:	VO_2____	HR_____	RPE____	FS_____	FAS____	S:___	G:___

****At the end of cool down, remove facemask and shut off monitor****

Post-CD: FS_____ FAS_____ AD-ACL_____ PACES _____

5-Min Recovery: FS_____ FAS_____

10-Min Recovery: FS_____ FAS_____ Post-SE ____

15-Min Recovery: FS_____ FAS_____ AD-ACL_____ PSPQ ____ PREF/TOL_____

APPENDIX E: EXERCISE CHOICE QUESTIONNAIRE

You have performed two exercise bouts during your last two trials here. For today's session, we would like you to choose one of those two exercise bouts to perform again. The exercise you perform today will be based solely on the choice you make and will be exactly the same as the session you choose. So, which exercise session would you like to repeat?

I chose this session because _____

_____

_____

APPENDIX F: FEELING SCALE

While involved in various activities, it is common to experience changes in mood. You may find what you are doing pleasurable or displeasurable. Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during the same activity. Scientists have developed this scale to measure such responses.

How Do You Feel Right Now?

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