Introduction

An extensive body of research exists on the affective states that occur with an acute bout of exercise.[1-4] A core dimension of the affective states experienced by an individual is hedonic tone or pleasure/displeasure. Hedonic theory [5] proposes that these valenced responses to a behavior may influence whether that same behavior will be repeated. Exercise-induced affect focuses on the relationship between affective responses and exercise with the premise that an individual who partakes in an acute exercise bout producing enhanced positive affect and reduced negative affect would be more likely to adopt exercise practices in the future.[6] Psychological outcomes associated with an acute exercise bout may influence exercise behavior through tension release,[7] improvement of mood,[8] enhancement of self-esteem [9] and a reduction in anxiety and depression.[8,10,11] Additionally, negative affective responses to a single exercise bout may produce barriers to subsequent exercise participation. [12]

Positive and negative affective states during and after exercise have been reported in the literature. Findings have been mixed, with positive [1,2] and negative [3] affective responses being reported.

Much of the research on the psychological responses to a single bout of exercise is conducted on a single age group, such as younger healthy women or older women. For example, decreased negative affective post-exercise responses and increased affective positive responses have been found in older women, [1] middle-aged women [4] and college-aged women [2] following a single bout of aerobic exercise. Less research is available on the effect of age on affective states. One such study comparing sedentary younger and older women found that an acute bout of exercise resulted in decreased positive responses and increased negative affective responses in both groups of women. [3]

Bandura's [13] Social Cognitive Theory of behaviour proposes that individuals gain attitudes from various sources, such as an individual's social network and the media. Self-efficacy, or one's beliefs in his/her capabilities to execute a particular course of action to satisfy a situational demand, is the key construct of the Social Cognitive Theory for explaining behavior. [13] Factors said to influence self-efficacy include mastery experiences (behavioural), modelling (cognitive), verbal persuasion (social) and interpretation of emotional or psychological arousal (physiological).[13] Self-efficacy has long been identified as an important predictor of future exercise behaviour. [14-16]

Exercise-induced affect is influenced by many factors including the physiological and psychological differences of the individual, the environment and the perceived attributes and specific demands of the exercise bout.[10] A reciprocal relationship has been found between self-efficacy and the affective responses to an acute exercise bout, whereby individuals with greater self-efficacy demonstrate more positive affective responses following an acute exercise bout [1,17,18] through mastery accomplishment.[13] As self-efficacy is said to be specific to the task being performed, the mastery experience mechanism may increase the likelihood of repeating the exercise task.

Advancing age is associated with a decline in aerobic and strength capacities and an increase in adiposity. [19,20] These changes can have an effect on an individual's physiological functional capacity (PFC), defined as the ability to perform the physical tasks of daily life. [21] It would appear that in the adoption stages of physical activity, an older sedentary individual with low PFC may have lower exercise-related self efficacy to partake in an acute bout of physical activity, thus providing a real barrier to future exercise participation. [22]

This study examined the self-efficacy and affective responses of non-exercising younger and older women to an acute exercise bout to determine whether aging has an effect on affective responses to exercise. It was hypothesized that older women would experience more negative affective responses and lower self-efficacy responses compared to younger women immediately following an acute bout of exercise.

Methods

Participants

Twenty five younger (mean age 19.9 ± .29 yrs; range 18-23 yrs; body mass index (BMI) 21.9 ± 2.43) and 25 older (mean age 55.7 ± 1.15 yrs; range 50-69 yrs; BMI 29.2 ± 6.16) women participated and gave their written informed consent to participate in this study as approved by a University Human Research Ethics Committee. Participants were recruited via advertisements in regional newspapers, television and radio and community bulletin board notices throughout North Queensland, Australia. Participants were required to be sedentary, classified as not having performed regular moderate exercise during the preceding 6 months. [23,24] Older participants were required to be 50 years of age or older and younger women between 18-25 years of age.

A physical activity readiness questionnaire (PAR-Q) was used to determine the medical history and physical activity readiness of the participants. The PAR-Q was designed to identify adults for whom physical activity was inappropriate or should seek medical advice concerning suitable types of activity. [25] Thirty three older women initially volunteered for the study, however eight women were excluded due to medications that would affect heart rate or from contraindications to the PAR-Q assessment. Thirty younger women initially volunteered of which five were excluded due to age.

Measurements

1. Exercise-specific self-efficacy scales measure a respondent's belief in their capabilities to successfully participate in exercise when faced with potential barriers. [26] Exercise self-efficacy beliefs were assessed via a four-item questionnaire [27] designed to determine participant's confidence in their ability to cycle at 60% VO_{2max} during an acute exercise bout without stopping for 5, 10, 15 and 20 minutes. Participants respond to each item on a 100-point percentage scale with 10% increments that range from 0% (not at all confident) to 100% (extremely confident). This measure is similar to self-efficacy measures used previously in the literature [1,3] and has been shown to be a valid and reliable method for assessing self-efficacy. [27] Internal consistency for this scale in the current study was .70.

2. In line with Tellegen, Watson and Clark's [28] hierarchical structure of affect, valenced responses and more specific affective responses inherent with acute exercise were measured. The valenced and arousal dimensions of basic affect were measured using the Feeling Scale (FS) [29] and the Felt-Arousal Scale (FAS). [30] The FS ranges

from -5 (very bad) to +5 (very good) with 0 (neutral) as the midpoint. The FAS is a 6-point scale measuring perceived activation that ranges from 1(low arousal) to 6 (high arousal). Internal consistencies for the current study were .60 for the FS and .70 for the FAS.

More specific affective responses to an acute exercise bout were assessed using the Exercise-Induced Feeling Inventory (EFI). [6] The EFI is a 12-item multidimensional scale measuring the degree to which participants are experiencing the four specific feeling states of revitalization, positive engagement, tranquility and physical exhaustion. The items of refreshed, energetic and revived represent the feeling state of revitalization. The items of enthusiastic, happy and upbeat represent the feeling state of positive engagement. The items calm, relaxed and peaceful represent tranquility and the items fatigued, tired and worn-out represent physical exhaustion. Participants respond to each inventory item on a 5-point scale ranging from 0 (do not feel) to 4 (feel very strongly). The EFI has been used extensively in exercise-affect studies. [3,24,31,32] Internal consistencies for the current study were .86 for positive engagement, .76 for revitalization, .87 for tranquility and .83 for physical exhaustion.

3. Perceived exertion measures an individual's perception of overall effort. Borg's [33] 15-point Rating of Perceived Exertion (RPE) scale was used to measure perceived exertion for this study. The scale ranges from 6-20 and contains verbal anchors at every odd integer to assist participants with rating their overall perceived exertion.

Procedure

Participants were required to attend the university on two occasions. On the initial visit, participants were given an information sheet and completed the consent form. Participants were then measured for resting heart rate (HR_{rest}) and resting blood pressure (BP_{rest}) as well as measured for height and weight. Height and weight measurements were used to determine body mass index (BMI). Participants then performed a six-minute submaximal graded exercise test (GXT) on a cycle ergometer to determine estimated maximum oxygen uptake ($\dot{V}O_{2max}$). The GXT was a modification of the Astrand-Rhyming test developed by Siconolfi et al., [34] consisting of a lower initial work rate of 25 watts. This lower initial work rate has been previously found to be more appropriate for unconditioned women. [22] The submaximal test required participants to pedal at a rate of 50rpm and an initial workload of 25 watts for 6 minutes. Workload was increased by 25 watts after 2 minutes and 4 minutes if HR was <70%HR_{max}. The average HR was taken between the 5^{th} & 6^{th} minute once steady state HR was achieved.

Prior to the second visit, the participants' cycling workload was established for 60% of the estimated $\dot{V}O_{2max}$. The $\dot{V}O_{2max}$ ($l.min^{-1}$) was firstly estimated from the Astrand-Ryhming nomogram [35] using the steady state heart rate and final stage workload and a regression equation for females, as devised by Siconolfi et al., [34] was then applied. Relative $\dot{V}O_{2max}$ was then determined by dividing $\dot{V}O_{2max}$ ($l.min^{-1}$) by the participants' weight and 60% of the estimated $\dot{V}O_{2max}$ calculated. Finally, the cycling workload was established in watts by using the equation:

$$\frac{\dot{V}O_{2max}\ (ml.min^{-1}) - 7}{10.8} \times \text{weight (kgs)}$$

Upon arrival for the second visit HR_{rest} was recorded and pre-exercise affect and self-efficacy determined immediately prior to exercise. Affective responses were obtained by participants verbally responding to a Likert scale. Instructions for each of the measures were given to participants. For example, instructions for the FS were as follows: “When participating in this exercise you may experience various changes in mood. Some people may find these changes pleasurable while other people may find them unpleasant. You may also find that your feelings fluctuate during the course of the exercise. Feel free to use the 10 points (-5 to +5) to describe how best you feel during the exercise period.” Instructions for the FAS were as follows: “I want you to estimate how aroused you are feeling. By arousal I mean ‘worked up’. You might experience high arousal in a variety of ways such as excitement, anxiety or anger. Low arousal might be experienced by you in a number of different ways such as relaxation, boredom or calmness.”

Participants were then instructed to pedal at 50 $revs \cdot min^{-1}$ for a duration of 20 minutes at their predetermined workload. Heart rate (HR) was recorded every minute while RPE was recorded every 5 minutes during the 20 minute exercise bout. HR was also measured immediately following exercise. Affect was again measured at the 10^{th} minute during and immediately following the 20^{th} minute of cycling. Self-efficacy was also determined immediately following the 20 minute exercise bout.

Data analysis

Physiological characteristics were analyzed using one way analysis of variance (ANOVA). Affective and self-efficacy outcomes and RPE ratings were analyzed using separate mixed design repeated measures ANOVAs. Two levels corresponding to the age of the groups (younger and older) were used for the between-subjects factor. The within-subjects factor of time of measure represented the prior to, during and immediately post exercise measures for the affective outcomes. Self efficacy data were analyzed using a two (age: younger and older) by two (time: prior to and post) mixed design. RPE responses were analyzed using a two (age: younger and older) by four (time: 5, 10, 15, 20 minutes during exercise) mixed design. When the assumption of sphericity was violated, the Hunydt-Feldt adjustments were used. Follow-up univariate contrasts were performed on significant effects to determine the significance of pairwise comparisons. Effect sizes (Cohen's *d*) accompanying the mean changes of the self-efficacy and affective responses were calculated by dividing the mean difference by the pooled standard deviation. [36] Bivariate correlation analysis was also used to determine whether relationships existed between self-efficacy and affective responses. Correlation analysis was also used to determine whether a relationship existed between the feeling scale and RPE responses.

Results

Descriptive statistics for demographic and physiological characteristics are presented in Table 1. ANOVA results revealed that the older women had higher resting systolic blood pressure (SBP_{rest}) ($F(1,48) = 7.423$, $p < .01$), resting diastolic blood pressure (DBP_{rest}) ($F(1,48) = 7.766$, $p < .01$), BMI ($F(1,48) = 30.029$, $p < .01$) and lower estimated $\dot{V}O_{2max}$ ($F(1,48) = 74.916$, $p < .01$) compared to the younger women.

RPE Results

Descriptive statistics for RPE responses are summarised in Table 2. Sphericity was not satisfied (Mauchly's W = 0.375, $\chi^2 = 45.79$, df = 5, $p < 0.01$), therefore the

Huynh-Feldt adjustment was utilized. Repeated measures ANOVA indicated that age did not significantly differentiate RPE ($F(1,48) = 0.52$, $p < 0.81$) measures during exercise. This result suggests that an exercise stimulus variation did not exist, thus ensuring that valid comparisons of affective responses could be made. However, a significant main effect for time of measure was found ($F(1,48) = 22.64$, $p < .01$) for RPE responses. Post hoc analysis revealed that ratings reported at 20 minutes were significantly higher than ratings reported at 5 and 10 minutes of exercise, when collapsed across age.

Affective Responses

Descriptive statistics for self-efficacy and affective responses are summarized in Table 3. ANOVA analysis of the EFI responses revealed a significant main effect for time of measure ($F(1,48) = 7.23$, $p < 0.01$) for positive engagement**.** Pairwise comparisons revealed that positive engagement increased significantly immediately following exercise compared to prior to and during exercise, when collapsed across age groups. A significant main effect for age ($F(1,48) = 10.26$, $p < 0.01$) was also found, whereby positive engagement responses were significantly higher in the older age group compared to the younger age group. No significant interaction between age and time of measure ($F(1,48) = 2.36$, $p < 0.12$) was found.

ANOVA analysis of “revitalization” demonstrated a significant main effect for time of measure ($F(1,48) = 12.33$, $p < 0.01$). Pairwise comparisons found that “revitalization” also increased significantly immediately following exercise compared to prior to and during exercise, when collapsed across age groups. No significant effect for age ($F(1,48) = 1.76$, $p < 0.20$) or interaction between age and time of measure ($F(1,48) = 3.25$, $p < 0.61$) was found for "revitalization" responses.

Analysis of "tranquility" responses revealed a significant main effect for time ($F(1,48) = 3.43$, $p < 0.05$) whereby "tranquility" significantly increased immediately following exercise compared to during exercise, when collapsed across age groups. A significant interaction was also found between time of measure and age for "tranquility" ($F(1,48) = 10.73$, $p <.01$). Pairwise comparisons revealed that the younger age group had significantly lower "tranquility" responses during and post exercise compared to the older age group. There was no significant main effect for age ($F(1,48) = 1.89$, $p <.18$) for "tranquility" responses.

Analysis of "physical exhaustion" responses revealed a significant main effect for age ($F(1,48) = 13.21$, $p < 0.01$). The younger age group had significantly higher "physical exhaustion" responses compared to the older age group. No significant main effect for time of measure ($F(1,48) = 0.70$, $p < 0.49$) or interaction between age and time of measure ($F(1,48) = 2.19$, $p < 0.13$) was found for "physical exhaustion" responses.

ANOVA analysis of the FS found a significant main effect for time of measure ($F(1,48) = 4.40$, $p < 0.02$) and a significant interaction between age and time of measure ($F(1,48) = 3.16$, $p < 0.05$). When collapsed across age groups, FS responses significantly decreased during exercise compared to prior to and post exercise. The younger age group also had significantly lower FS responses immediately following exercise compared to the older age group. No significant main effect for age ($F(1,48) = 1.15$, $p < 0.29$) was found.

The FAS analysis found a significant main effect for time of measure (*F*(1,48) = 8.43, $p < 0.01$). FAS responses significantly increased immediately following exercise compared to prior to and during exercise, when collapsed across age groups. No significant main effect for age (*F*(1,48) = 0.00, $p < 1.10$) or interaction between age and time of measure (*F*(1,48) = 0.56, $p < 0.56$) was found. Effect sizes for affective responses varied from small to high with the smallest change occurring in positive engagement (*ES* = -0.02) and the greatest change occurring in revitalization (*ES* = -0.97).

Self-efficacy

ANOVA analysis of self-efficacy responses demonstrated a significant main effect for time of measure (*F*(1,48) = 80.72, $p < 0.01$). Pairwise comparisons revealed self-efficacy significantly increased immediately following exercise compared to prior to exercise, when collapsed across age groups. A significant main effect for age (*F*(1,48) = 7.07, $p < 0.02$) was also found. The younger age group had significantly higher overall self-efficacy compared to the older age group. Lastly, a significant interaction between age and time of measure (*F*(1,48) = 10.15, $p < 0.01$) was found, whereby the younger age group had significantly higher self-efficacy prior to exercise compared to the older age group. Effect sizes for self-efficacy change were in the high range for younger (*ES* = -1.06) and older (*ES* = -1.55) women.

Correlation analysis

Bivariate correlations were used to determine whether relationships existed among self-efficacy and affective responses to exercise (Table 4). No significant correlations were found between self-efficacy prior to exercise and affective responses during exercise. However, a trend was observed between self-efficacy prior to exercise and “tranquility” (r = .35, p = .08) and “physical exhaustion” (r = -.36, p = .07) during exercise, suggesting that the more efficacious participants reported higher tranquility and lower levels of fatigue during exercise.

Significant correlations were found between self-efficacy immediately following exercise and “tranquility” (r = .48, p = .01), “physical exhaustion” (r = -.59, p = .00) and Feeling Scale (r = .46, p = .02) responses during exercise. These results suggest that participants who reported greater feelings of “tranquility”, less fatigue and more positive feeling states during exercise felt more efficacious immediately following exercise. A trend was also observed between self-efficacy immediately following exercise and “revitalization” during exercise (r = .38, p = .06), suggesting that participants reporting greater feelings of “revitalization” during exercise felt more efficacious immediately following exercise. No significant correlations were found between self-efficacy immediately following exercise and Felt Arousal Scale responses during exercise.

Significant correlations were found between exercise self-efficacy immediately following exercise and “revitalization” (r = .58, p = .00), tranquility (r = .40, p = .04) and “physical exhaustion” (r = -.60, p = .00) immediately following exercise. These results suggest that participants with greater post exercise self-efficacy have greater feelings of “revitalization”, “tranquility” and less fatigue immediately following exercise.

Finally, correlation analysis was also conducted to determine whether a relationship existed between the RPE response and the FS and FAS responses reported during exercise and the RPE response reported at 20 minutes of exercise and FS and FAS responses immediately following exercise (Table 5). Significant correlations were found between the RPE and FS ($r = -.48$, $p = .00$) and FAS ($r = .303$, $p = .05$) responses during exercise, whereby a higher RPE response correlated with a lower FS and higher FAS response. A significant correlation was also found between RPE responses at 20 minutes of exercise and FS responses immediately following exercise ($r = -.525$, $p = .00$). Therefore, a higher RPE response at 20 minutes of exercise correlated with a lower Feeling Scale response immediately following exercise. No significant correlations were found between RPE responses at 20 minutes of exercise and FAS responses immediately following exercise.

Discussion

This investigation found that an acute bout of moderate-intensity exercise produced more positive and fewer negative affective states in both younger and older women. The results therefore do not support the hypothesis that older women would experience more negative affective states compared to younger women following an acute bout of exercise. In fact, for this group of women, age does not seem to have a deleterious effect on affective states during exercise. These findings are consistent with previous investigations on acute exercise bouts. [1,2]

However, the current findings are in contrast to Focht et al., [3] who found that both younger and older participants experienced more negative and less positive responses to an acute exercise bout. A possible explanation for the differences between the psychological responses may be due to the variation in methodology. Participants in the current study were working at a lower intensity of 60% $\dot{V}O_{2max}$ compared to participants in Focht et al.'s study of 65% $\dot{V}O_{2max}$. The sedentary individuals may have perceived the higher intensity as overly challenging. RPE scores support this view. The current study's RPE scores ranged from "fairly light" to "somewhat hard" throughout the exercise bout. In contrast, RPE scores of participants in Focht et al.'s study ranged between "somewhat hard" and "hard". Negative relationships between exercise intensity and affective responses have been previously reported. [1,24,37] As physiological cues influence exercise-induced affect [10] it would be feasible that sedentary older women who experience physical exertion would have unpleasant affective responses. [22] For sedentary older women, the intensity of 60% $\dot{V}O_{2max}$ may elicit more favorable responses to an acute bout of exercise and may lead to the increased possibility of future exercise participation.

The finding that the older women experienced more positive than negative affective responses from the exercise bout was unexpected. Age-related physiological changes negatively affect an individual's PFC. [21] A 10% per decade decline in $\dot{V}O_{2max}$ occurs in sedentary adults from the age of 30 years. [38] In addition to physiological changes, aging also brings about changes in mood disturbance, namely increased negative affect and decreased positive affect. [39] It would therefore be expected that an exercise bout would elicit more negative responses from the older women. A possible explanation for these results is that the older women had a positive experience through mastery accomplishment. Exercise self-efficacy increased for both groups of women immediately following exercise. Self-efficacy is said to be specific to the task being performed. [13] Therefore, exercise self-efficacy levels may have increased for this particular task through a sense of accomplishment at completing 20 minutes of moderate intensity exercise. One exercise barrier for older adults is the perception that exercise will be tiring, causing concerns for their health. [40] However, the women were able to complete the exercise bout feeling no ill effects despite being fatigued during the task. This may have implications for future exercise participation. Giving sedentary older women the opportunity to successfully complete a moderate-intensity exercise activity may promote a sense of accomplishment and the perception that exercise can be an enjoyable experience. Repeated success in the chosen activity will raise mastery expectations through the acquisition of a skill for dealing with stressful situations. [13] This will ultimately increase efficacy beliefs.

However, while exercise self-efficacy increased for both groups of women, pre-exercise self-efficacy did differ as a function of age. The younger women experienced higher levels of task-specific exercise self-efficacy compared to the older women prior to the exercise bout. This would be in keeping with the idea that generational circumstances may influence exercise self-efficacy. Many older women believe that they are unable to perform an activity before a first attempt is made, due to a lack of experience or knowledge regarding exercise, particularly if they have been socially discouraged from participating in exercise in their younger years. [41] The lack of sporting opportunities as girls coupled with a strong social commitment to their families may result in older women lacking the confidence to pursue an exercise regime at this time in their life. [41] These women have now found themselves in a new cultural period whereby they are being told that exercise is an essential component of good health. [40] Exercise and health professionals should consider the self-efficacy of older sedentary women when prescribing exercise. Identifying older women with lower exercise self-efficacy in the early stages of exercise adoption may benefit from informational and motivational instruction to increase their exercise efficacy beliefs. [42]

In regards to whether age would moderate basic affective responses, this study obtained mixed findings. Both groups of women experienced increases in the Felt-Arousal Scale following exercise compared to prior to and during exercise. In addition, Feeling Scale responses decreased from baseline during exercise for both groups, however this decrease did not persist for the older women when post exercise measures were taken. The older women experienced decreased fatigue and higher positive engagement prior to, during and after exercise and higher tranquility levels during and post exercise. Increased revitalization, tranquility and positive engagement post exercise occurred for both groups. These findings suggest that while both groups perceived they were exerting themselves during the exercise bout, the older women found this exertion as a positive experience once they had completed the activity. [43] This further supports the idea that mastery accomplishment was perceived by the older women for completing a bout of moderate-intensity exercise. Past experiences in an exercise activity can therefore shape an individual's self-efficacy.

The fact that physical exhaustion, positive engagement and tranquility were a function of age may also suggest that the older women had a more enjoyable exercise experience compared to the younger women. Exercise enjoyment is thought to have an influence on the psychological responses to exercise. [2] However, the current study did not measure exercise enjoyment and therefore can only speculate on this relationship. Further studies on the relationship between exercise enjoyment and the affective responses of women of differing ages are warranted.

A reciprocal relationship between self-efficacy and affective responses was demonstrated in the current study and is consistent with the literature. [1,3,17] Results of the correlation analysis revealed that participants who reported greater feelings of tranquility, less fatigue and more positive feeling states during exercise felt more efficacious post exercise. In addition, participants with greater post exercise self-efficacy had greater feelings of revitalization, tranquility and less fatigue post exercise. Bartholomew and Miller [17] found participants who had perceived a strong sense of mastery accomplishment reported greater positive well-being following an acute exercise bout. The mastery experience mechanism may do well towards increasing future exercise self-efficacy for performing stationary cycling in this group of sedentary women.

A number of limitations in the current study should be addressed. The relatively small sample of participants means that interpretation of the current findings should be taken with caution. However, post exercise effect sizes were generally moderate to large, supporting the significant findings. Secondly, the findings are only relevant to sedentary women and may not be able to be replicated for male sedentary participants. As gender specific differences in psychological responses to exercise may exist, further studies including male sedentary participants or differences with active individuals of either gender is recommended. Thirdly, exercise enjoyment was not measured and therefore the author can only speculate as to whether the older participants found the exercise experience to be an enjoyable one. Lastly, only one exercise intensity of 60% $\dot{V}O_{2max}$ for a duration of 20 minutes was employed in the current study. Exercise bouts of varying intensities and durations may elicit quite different responses from participants.

In conclusion, this study found that older sedentary women did not experience more negative affective states following a bout of exercise compared to younger sedentary women. This would suggest that for this group of women, aging does not have an effect on affective states. The older women in particular experienced more positive affective states following a bout of moderate-intensity exercise. As advancing age is associated with an increased risk of chronic cardiorespiratory conditions it is important that older women maintain an active life.

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