2020

Affective Response to Upper Body and Lower Body Exercise

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AFFECTIVE RESPONSE TO UPPER BODY AND LOWER BODY EXERCISE

by

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A thesis submitted in partial fulfillment of the requirements
for the Honors in the Major Program in Kinesiology
in the College of the Health Professions & Sciences
and in the Burnett Honors College
at the University of Central Florida
Orlando, Florida

Fall Term
2020

Thesis Chair: David H. Fukuda

ABSTRACT

More than one-half of university students in the United States and Canada are not active enough to gain health benefits. Enjoyment of exercise proposes a feasible solution to the absence of motivation surrounding physical activity. The purpose of this study is to compare the differences in reported enjoyment between upper and lower body cycling graded exercise to exhaustion (GXT). Seven university students (23 ± 3 years old; 26 ± 4 kg/m2) performed two randomized graded exercise tests on different days: one for upper body, one for lower body. Feeling Scale (FS) measured the affective response during exercise. Post-exercise enjoyment values were recorded 15 minutes after concluding GXT using the Physical Activity Enjoyment Scale (PACES), which has been shown to be a valid and reliable measure of physical activity enjoyment. Paired t-tests were used to evaluate mean differences between upper and lower body GXT enjoyment scores. Rank biserial correlations and Cohen's d values were used to evaluate effect size for the non-parametric and parametric analyses. Alpha level was set a priori at $p < 0.05$. Means and standard deviations were calculated for PACES, age, and BMI. No significant differences were found for enjoyment ($p=0.162$) between upper (104.3 ± 12.6) and lower-body cycling (97.8 ± 15.3). Notable effect sizes were found for the PACES Total and several subscales (Enjoy/Hate, Pleasant, and Contentment). No significant differences were found for the FS at ventilatory threshold ($p=0.586$) or at maximal aerobic power ($p=0.670$) between the upper and lower body GXT trials. More research is needed to explore exercise enjoyment across different exercise modes and provide a more particular evaluation of PACES subscales. Further research should aim to compare enjoyment levels across different physical activity levels (e.g., low, moderate, high), between sexes and within diverse populations.

ACKNOWLEDGEMENTS

My deepest and most sincere gratitude to everyone who played a role in the completion of this thesis. Thank you to my family and friends who have supported me throughout this process and to my fiancé who has always believed in me and pushed me to be the best version of myself. To my thesis chair, Dr. Fukuda, thank you for your guidance and expertise, endless encouragement, and confidence in my academic abilities. Thank you to Nicolas Clark for making me aware of the opportunity to complete an undergraduate thesis and for the knowledge and research experience I have gained from working with you. I would also like to thank Dr. Jeffery Stout for serving as a member of my thesis committee.

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INTRODUCTION

The benefits of exercise are numerous and diverse, encompassing disease prevention, mental health, quality of sleep, body composition, and overall physical health (Oliveira & Slama, 2013; Lavie & Ozemeck, 2019; Niven & Laird, 2020; Gorgey, 2014). Despite the widespread knowledge and undeniable advantages of physical activity and exercise, more than one-half of university students in the United States and Canada are not active enough to gain health benefits (Irwin, 2004). A variety of explanations for the absence of exercise within a population identified in literature manifests in two forms: barriers and motivators. An exercise barrier impedes or prevents one from exercising while an exercise motivator causes or drives a person to exercise (Bartlett, 2009; Ebben, 2008; Heesch, 2000; Joseph, 2019). The scientific evidence supporting the essential role of exercise continues to grow along with national resources encouraging physical activity.

In a study conducted in 2019, a team of researchers aimed to identify the perceived benefits and barriers to exercise among individuals with class III obesity (Joseph, 2019). These perceived barriers were found to be similar to those of people of normal weight, extending the relevance of the data to populations beyond obesity (Joseph, 2019). Enjoyment and related aspects, such as pleasure and energy, are commonly perceived barriers in the U.S. and have been shown to influence a variety of different groups, including people of different ages, races, ethnicities, sex, education levels, and socioeconomic and health statuses (Bartlett, 2009; Ebben, 2008; Heesch, 2000; Joseph, 2019). In university, students surveyed across the United States of America, “no motivation” was the fourth most common barrier to exercise (Ebben, 2008). Enjoyment of exercise proposes a feasible solution to the absence of motivation surrounding physical activity. Therefore, it is important to understand both the barriers and motivators of exercise to successfully encourage and increase exercise adherence (Bartlett, 2009; Ebben, 2008; Heesch, 2000; Joseph, 2019).

The weaknesses of dominant cognitive-based theories in explaining health behavior have led to a focused curiosity in affective responses to exercise (Williams & Rhodes, 2019; Niven & Laird 2020). Affective responses can be used as an umbrella term for the inter-related concepts, including core affect, pleasure/displeasure, and arousal (Berger & Tobar, 2011; Niven & Laird 2020). Enjoyment, an affective response, is defined as an optimal psychological state, and enjoyable experiences enhance the quality of life (Berger & Tobar, 2011). The study of enjoyment may introduce an effective strategy for overcoming barriers and capitalizing on the motives of exercise to increase exercise adherence (Ebben, 2008). The quantification of enjoyment by the Physical Activity Enjoyment Scale (PACES) provides a validated instrument that can be used post-exercise to assess the extent to which an individual enjoys doing any type of physical activity (Kendzierski & DeCarlo, 1991; Moore & Yin, 2009; Motl & Dishman, 2001).

One way to integrate enjoyment and exercise is by manipulating exercise intensity. Although multiple studies have attempted to increase exercise adherence by manipulating intensity, the relationship between affective responses and intensity remains unclear (Foster & Farland 2010; Niven & Laird, 2020). Evidence of higher enjoyment levels across different exercise intensities differs (Bartlett, 2009; Foster & Farland 2010; Niven & Laird, 2020). Differences may be attributed to training status, previous activity level, exercise frequency, or self-selection of intensity (Bartlett, 2009; Frazão, 2016; Hagberg, 2009; Rose, 2008). However, enjoyment of exercise is consistently utilized to rationalize exercise preference, and how one feels during exercise can also be a strong predictor of future exercise behavior (Greene 2018).

Beyond activity level and intensity, another critical aspect of exercise is modality. The distinction between the upper body and lower body is a popular way to organize training programs, daily routines, and general exercise prescription. The comparison between upper and lower body is vital as most recent exercise recommendations specify intensity, but not modality (Greene, 2018).

The purpose of this study is to compare the differences in affective response between upper body and lower body cycling graded exercise to exhaustion (GXT). Modifying modalities to accommodate positive affective responses may encourage exercise adherence by overcoming a common barrier of exercise, advantageously using common motivators, and contributing to the overall quality of life.

REVIEW OF LITERATURE

Exercise Adherence

Only about 23 percent of all U.S. adults perform 150 minutes of moderate physical activity or 75 minutes of vigorous physical activity per week, which is the minimum recommended amount of activity associated with reduced chances of heart disease and premature death (Blackwell & Clarke, 2018). The majority of overweight or obese Americans do not exercise at all (Ebben, 2008). A comprehensive study aimed at understanding the barriers and motivators of exercise showed that enjoyment, or lack thereof, was a common theme among subjects that do not exercise (Ebben, 2008). Among non-exercisers, “more motivation” was reported as a factor that would lead them to exercise (Ebben, 2008). The same study stated, “enjoyment/pleasure” as the fourth most common motivator, placing itself among at least three other studies where “enjoyment/pleasure” was ranked fourth through ninth as an exercise motivator (Ebben, 2008).

Similar barriers were reported in individuals with class III obesity (Joseph, 2019). A high proportion of these individuals, approximately 70-80%, agreed that perceived exertion and fatigue prevented them from exercising (Joseph, 2019). Time constraints, limited access to exercise facilities, lack of enjoyment, fear of injury, and motivation were also consistently identified as exercise barriers (Joseph, 2019). Another study focused on barriers in older women of different racial and ethnic groups across the stages of physical activity behavior: Pre-contemplation/contemplation, preparation, action, and maintenance (Heesch, 2000). Each stage's significant barriers were being too tired and lacking energy in Caucasian, Native American/ Native Alaskan, African American, and Hispanic women (Heesch, 2000).

Lack of exercise within all populations can lead to increased health risks, including coronary heart disease, stroke, high blood pressure, and all cause-mortality (Lavie & Ozemeck, 2019). The Physical Activity Guidelines for Americans serves as a resource for health professionals and policymakers as they attempt to implement exercise adherence across the nation (U.S. Department of Health and Human Services, 2018). Based on the Physical Activity Guidelines Committee's scientific report, these guidelines promote enjoyment as a useful component of exercise (U.S. Department of Health and Human Services, 2018; Physical Activity Guidelines Advisory Committee, 2018).

Affective Response to Exercise

In addition to the health benefits of exercise, enjoyable exercise sessions may facilitate exercise adherence (Berger & Tobar, 2011; Greene, 2018). Positive exercise experiences can also influence a participant's quality of life (Berger & Tobar, 2011). Quality of life and affective responses to exercise are important to members of the general population (Berger& Tobar, 2011; Niven & Laird, 2020). The Physical Activity Enjoyment Scale (PACES) provides a reliable and valid measure of enjoyment, an affective response, in various populations (Kendzierski & DeCarlo, 1991; Moore & Yin, 2009; Motl & Dishman, 2001).

The development of PACES began with a list of 39 bipolar items based on examination of the exercise adherence and enjoyment in literature, the reported descriptors of feelings experienced while engaged in physical activity, and the use of words and phrases used in discussion between authors about affective experiences regarding physical activity and exercise (Kendzierski & DeCarlo, 1991). Experts in the field of exercise adherence then consolidated these items, resulting in a list of 18 bipolar statements that reflected the most relevant aspects of enjoyment scored on a 7-point scale (Kendzierski & DeCarlo, 1991). Aspects of enjoyment include hate/likeness, boredom/interest, pleasure, fun, energy, happiness, frustration, gratification, exhilaration, stimulation, accomplishment, refreshment, invigoration, feeling, and contentment (Kendzierski & DeCarlo, 1991). It should be noted that these aspects of enjoyment are also some of the previously mentioned barriers and motivators of exercise.

When studying affect, it is also essential to consider the timing of the assessment. While useful, PACES only provides insight into affective responses post-exercise. Studies in which affective assessments are administered prior to and following exercise have reported significantly different results than those in which affective responses are measured during exercise (Williams, 2008). A multi-dimensional approach in which affect can be measured in various phases (i.e., before, during, and after) offers a more reliable methodological application.

Affective responses during exercise are crucial in determining other psychological responses to exercise and could potentially play an important role in future adherence (Greene, 2018). Although in-task affect has been linked to exercise enjoyment (Greene, 2018), how one feels during exercise at varying intensities may or may not include enjoyment. The Feeling Scale (FS) is an 11-point, single item, bipolar measure of pleasure/displeasure that can also be used to assess affective response during exercise (Greene, 2018). It is typically used in addition to other measures focused on pre-to-post affective changes (Greene, 2018; Rose, 2008). While PACES explores the extent to which an individual enjoys physical activity using categories of emotion, the FS aims to evaluate the pleasure/displeasure of core emotions using good/bad bipolarization (Kendzierski & DeCarlo, 1991; Hardy & Rejeski, 1989). The commonality between these affective responses overlap in their characteristic positivity; thus, the contribution of the FS and PACES questionnaire together assess affective responses both amid and post-exercise.

Exercise Frequency and Intensity

In a study investigating the importance of enjoyment in exercise interventions, associations between changes in enjoyment and changes in exercise frequency were demonstrated (Hagberg, 2009). The same study concluded that the focus of exercise prescription should be shifted to satisfaction and enjoyment and that enjoyment of exercise may be important for the long-term effectiveness of exercise interventions (Hagberg, 2009).

Multiple studies have attempted to increase exercise adherence by manipulating intensity. A study conducted in 2009 compared exercise enjoyment between high and moderate intensity exercise and found that high-intensity interval training is perceived to be more enjoyable than moderate-intensity training (Bartlett, 2009). Studies like these have inspired the notion that high-intensity interval training has the potential to optimize the magnitude of adaptation resulting from physical training, while minimizing the time and effort devoted to training (Foster & Farland, 2010). However, everyday experience suggests that higher intensity exercise is typically less comfortable and may be perceived as less enjoyable, especially for individuals with lower cardiorespiratory fitness (Foster & Farland, 2010; Greene, 2018). One study advised that high-intensity interval training should be used cautiously regarding affective responses (Oliveira & Slama, 2013). Despite this inconsistency presented in the literature, the evaluation of the significance of enjoyment of exercise persists.

Another component consistent in literature is the use of rating of perceived exertion, or RPE. The RPE is a psychophysiological category scale that requires respondents to estimate the magnitude of exertion they perceive during exercise (Hardy & Rejeski, 1989). However, RPE may not accurately reflect the affect a person feels during exercise (Hardy & Rejeski, 1989). RPE and FS are similar in their measures but differ in their conceptual identities (Hardy & Rejeski, 1989). Individuals may report the same RPE but feel differently. For example, highly trained athletes may enjoy nearing fatigue and accept this as a positive challenge. Others may find exercise at a higher RPE uncomfortable or unpleasant. Researchers have found that the FS accounts for variability in feeling that RPE does not (Hardy & Rejeski, 1989). Additionally, using the International Physical Activity Questionnaire (IPAQ) to compare physical activity levels may provide further insight (Hagströmer, 2006). The present study is primarily concerned with affective responses to exercise.

Moreover, a systematic review and meta-analysis revealed no difference in affect between intensities at the end of exercise, implying that this relationship may not differ by type of exercise in terms of future behavior (Niven & Laird, 2020). In fact, enjoyment levels continue to increase following the initial introduction to training, and the intensity at which exercise is performed is a determinant of affective response (Smith-Ryan, 2015; Rose, 2008). For people who do not exercise, “dislike of exercise” is a common exercise barrier (Ebben, 2008). Increasing exercise frequency or increasing exercise enjoyment may lead to increased exercise adherence (Hagerg, 2009; Smith-Ryan, 2015). A study conducted in 2008 found that allowing individuals to self-regulate their intensity results in a more pleasant exercise experience, further demonstrating the importance of preference within exercise (Rose, 2008). Allowing subjects to choose modality may increase enjoyment in a similar way.

Modalities of Exercise: Upper Body vs. Lower Body

It may be beneficial to examine affective change using varying exercise conditions across different modalities (Greene, 2018). This comparison is vital as most recent exercise recommendations specify intensity, but not modality (Greene, 2018). The preference for exercise modality is critical to exercise adherence (Bartlett & Close, 2011). Furthermore, choosing different kinds of exercise is an important factor for making exercise more enjoyable (Hagberg, 2009; Rose, 2008). Although the upper body and lower body exercise generate a similar inflammatory response (Leicht, 2016), upper body exercise typically involves smaller muscular mass, which corresponds to lower cardiorespiratory and metabolic responses (Olivier, 2008). However, when investigating cardiovascular responses to upper body exercise in normal and cardiac patients, it was found that the central and peripheral responses to either upper body or lower body exercise appear to be independent of the muscle mass employed and directly related to specific relative exercise intensity (Miles, 1989). Furthermore, thermoregulatory responses are independent of the size of the muscle employed (Sawka, 1984).

In cycling, lower body exercise induces higher peak heart rate, submaximal $VO_{2,}$ and ventilation (Olivier, 2008). Upper body exercise results in a higher blood lactate concentration at a relative VO_2 output (Olivier, 2008). However, this is because the lactate threshold generally occurs later in lower body exercise. Essentially, both modalities induce similar physiological responses, but differences in threshold placement may be related to the upper body musculature's lower training status. This suggests that a more enjoyable modality, as chosen by the subject, may serve as an effective alternative form of exercise for another.

Moreover, thoughtful exercise design is critical for populations restricted to modalities (Leicht, 2016). Persons with spinal cord injuries experience rapid muscle mass loss, which leads to serious metabolic consequences (Gorgey, 2014). Exercise can ameliorate many health problems and medical conditions associated with spinal cord injuries (Gorgey, 2014). Implementation of exercise programs encompassing a specific modality and dictated by affective response may provide people of different ages, sex, races, ethnicities, education levels, socioeconomic statuses, and health statuses with the necessary opportunities to exercise.

METHODOLOGY

Subjects

The target population of this study was university students, primarily recruited at the University of Central Florida (UCF). Subjects had to be males or females between 18 and 44 years old and willing to complete all testing visits to complete their participation in this study. Exercise risk, determined using the Physical Activity Readiness Questionnaire (PAR-Q+), should be low. Physical activity level was reported through the use of the International Physical Activity Questionnaire (IPAQ). Subjects had to also speak and understand the English language, along with the study procedures, in order to sign the informed consent document willingly.

Participants were excluded from the study if they were an amputee, could not complete all testing visits to the Laboratory, or were not apt to participate in physical activity, as determined by the PAR-Q+. Those who required medical clearance to participate but were unable to obtain medical clearance from a health care professional did not participate. Participants with a pacemaker or any chronic illness causing the individual to seek medical care were excluded. Seven university students (23 ± 3 years old; 26 ± 4 kg/m2) participated in this study.

Instruments

Participants performed arm and leg cycling maximal graded exercise tests (GXT). For the purpose of this study, upper body exercise was classified as testing with an electromagnetically braked arm ergometer (Brachumera, Lode, The Netherlands), and lower body exercise was classified as testing with an electromagnetically braked leg ergometer (Corival, Lode, The

Netherlands). Breath-by-breath gas exchange data were collected using a metabolic gas analyzer (K-5 CPET, Cosmed, Rome, Italy). Oxygen uptake ($\dot{V}O_2$), carbon dioxide output ($\dot{V}CO_2$), and ventilation (VE) will be measured continuously using a breath-by-breath mode. Exercise enjoyment values were recorded using the Physical Activity Enjoyment Scale (PACES; Table 1) following exercise. The Feeling Scale measured the affective response during exercise.

Procedures

Subject participation in this study included multiple visits, with separate data collected each visit. The first visit following recruitment included screening for eligibility, informed consent, and the PARQ+. The second visit, or familiarization visit, introduced subjects to the ergometry equipment. Body mass, height, and body composition were also assessed. The third and fourth visits, in which performance tests were completed, were randomized with subjects performing different tests on different days in no particular order. The third and fourth visits began with a warmup, followed by a gradual increase in power output.

Subjects were expected to maintain between 70-80 revolutions per minute and exercise until volitional fatigue was identified as cadence dropping below 65 rpm for more than 3 s despite verbal encouragement. The upper body GXT consisted of a 5-minute warmup at 15 watts with a work-rate increase of 15 watts every minute for males. For females, the warmup was 5 minutes at 10 watts with a work-rate increase of 10 watts every minute. The lower body GXT consisted of a 5-minute warmup at 50 watts with a work-rate increase of 35 watts every minute for males. For females, the warmup was 5 minutes at 50 watts with a work-rate increase of 30 watts every minute. Maximal aerobic power was determined as the highest work-rate achieved during the GXT. Ventilatory threshold (VT) was determined using the V-slope method signifying a departure of $\dot{V}CO_2$ from a regression line generated using $\dot{V}O_2$ data (Beaver, 1986), and the corresponding time and power output were recorded.

Each participant provided a baseline FS prior to testing. Once testing began, FS was recorded every 2 minutes. The RPE scale was used once the test was complete to confirm maximal effort. CPR and First Aid certified researchers were prepared to stop testing immediately if the subject experienced moderate to severe angina, cyanosis, pallor, shortness of breath, wheezing, arm or leg cramps, or any other signs of discomfort not related to exercise at high intensity. Participants were given the PACES questionnaire 15 minutes after concluding GXT.

Data Collection and Statistical Analysis

Higher PACES scores denote higher levels of enjoyment. Paired t-tests were used to evaluate mean differences between upper and lower body GXT enjoyment scores. Means and standard deviations were calculated for PACES, age, and BMI. All data were evaluated for normality using Shapiro-Wilk tests. The PACES total score, PACES sub-scores, and Feeling Scale values between upper and lower body GXT trials were compared with Wilcoxon signed ranked tests, while power output and time at ventilatory threshold and maximal aerobic power, and VT as a percentage of maximal aerobic power were compared with dependent samples t-tests. Rank biserial correlations and Cohen's d values were used to evaluate effect size for the non-parametric and parametric analyses, respectively. An alpha of $p<0.05$ was set a priori to determine statistical significance. All analyses were conducted with an open-source statistical analysis software program (JASP; version 0.13.1).

RESULTS

Table 2 contains data for the PACES total score and power output, time, and FS values at the ventilatory threshold and maximal aerobic power during the upper and lower body GXT trials.

PACES and Feeling Scale

No significant differences between the upper and lower body GXT trials were shown for the PACES total score (W=24; p=0.109) or any PACES sub-scores (p>0.05; Figure 1). However, notable effect sizes were found for the PACES Total (rank biserial correlation: 95% confidence interval=0.068 to 0.938) as well as the Enjoy/Hate (W=10; p=0.089 rank biserial correlation: 95% confidence interval= 1.000 to 1.000), Pleasant (W=24; p=0.103; rank biserial correlation: 95% confidence interval=0.068 to 0.938), Gratification (W=3.0; p=0.346; rank biserial correlation: 95% confidence interval= 1.000 to 1.000), and Contentment (W=1.0; p=1.000; rank biserial correlation: 95% confidence interval= 1.000. to 1.000) subscales with the potential for higher scores during the upper body GXT compared to the lower body GXT.

No significant differences for the Feeling Scale at ventilatory threshold (W=4.5; p=0.586) or at maximal aerobic power (W=17; p=0.670) were found between the upper and lower body GXT trials.

Power Output and Time

Power output at ventilatory threshold (t(6)=-3.802; p=0.009; Cohen's d: 95% confidence interval= -2.497 to -0.326) and maximal aerobic power (t(6)=-8.331; p < .001; Cohen's d: 95% confidence interval= -5.021 to 1.253) were significantly different between the upper and lower body GXT trials. No differences were found between the time at ventilatory threshold (t(6)=-1.795; p=0.123; Cohen's d: 95% confidence interval= -0.174 to 1.487) during the upper and lower body GXTs; however, significant differences were found for the time at maximal aerobic power ($t(6)=2.919$; $p=0.027$; Cohen's d: 95% confidence interval= 0.118 to 2.037).

DISCUSSION

Affective Response

The main finding of this study was that there was no significant difference between affective responses in the upper body and lower body exercise. Participants did not find a specific modality of exercise to be more enjoyable than the other. While a majority of the subjects reported being physically active, their enjoyment of exercise modalities did not differ significantly despite a significant difference between lower and upper body performance. The assumption that there is no preference in modality is in agreement with the notion that initial fitness does not seem to be a major determinant of exercise enjoyment (Barlett, 2009). Physical activity levels may be irrelevant when examining the enjoyment of exercise.

When examining the individual responses to the PACES questionnaire, no significant difference was found. This may answer the question posed by Kendzierski & DeCarlo when the PACES scale was created in 1991—is enjoyment unidimensional or can it be broken down into its component parts? Despite separate analyses, the conclusions were the same, suggesting that the individual components that contribute to enjoyment also reflect the measure of enjoyment independently.

However, there were notable effect sizes for the PACES total score, Enjoy/Hate, Pleasant, Gratification, and Contentment subscales with the potential for higher scores during the upper body GXT compared to the lower body GXT. It should be noted that Enjoy/Hate, Pleasant, and Contentment can be further categorized as items that reflect a generalized state of enjoying activity (Raedeke, 2007). While it is unclear if these effects are a function of the study or impacted by the small sample of the current investigation, it may be beneficial to explore what accounts for the variation in the correlation between PACES subscales during upper and lower body exercise through follow-up investigation.

No significant differences were identified for Feeling Scale values across different exercise intensity domains. It is suggested that individuals evaluate exercise differently, and this cognitive individuality may explain variability in affective response during specific exercise intensities (Rose, 2008). Examining the changes of FS values throughout the GXT showed that during upper body and lower body exercise, some participants reported either a gradual decline in affect or a consistent positive affect after reaching the ventilatory threshold (Figure 2; Figure 3). This is consistent with other studies, given that as exercise intensity approaches the ventilatory threshold or lactate threshold, affective responses become highly variable, with some individuals showing positive affective response while others demonstrate a decline in positive affective response (Greene, 2018; Ekkekakis, 2011; Williams, 2008). However, these studies were conducted with sample sizes larger than 19 (Greene, 2018; Ekkekakis, 2011; Williams, 2008). A more frequent recording of FS values and a larger sample size may be required to observe trends in FS overtime.

Cardiorespiratory performance and metabolic responses

The power output values were recorded to verify affective responses related to physiological, cardiovascular, and metabolic responses. The differences in power output caused by changes in exercise mode were considered when developing the GXT protocols. As expected, the percentage of maximal power output at the ventilatory threshold was the same during the upper and lower body trials despite differences in absolute power output. This also supports the current finding of no significant difference in FS values at the relative exercise intensities at which VT occurred. The FS, which has been shown to successfully regulate intensity (Cavarretta, 2019), further supports the need for protocol adjustments for absolute and relative intensity when conducting physiological assessments and when developing training programs.

CONCLUSION

Relevance & Future Research

Upper body exercise was not perceived as better or worse than lower body exercise despite a lower absolute performance. Arm cranking may be a reasonable alternative to lower body exercise and can be used in research to compare exercise-related outcomes between the upper and lower extremities. A lack of exercise modality preference may provide additional opportunities and encouragement for exercise enjoyment and adherence in assorted populations. For example, individuals may choose to substitute arm cranking for cycling without sacrificing enjoyment during physical activity and vice versa.

However, the specific rationale for this conclusion remains unknown. It is possible that the novelty of arm-cranking and limited prior training of upper body muscle groups led to an abnormal identification of enjoyment. It should be noted that with small sample size, this data may not accurately represent the entirety of affective responses across populations. As a pilot study, arguably some of the most useful information learned from this study was the small details that may be lost in the transition from protocol writing to actual implementation. For example, a full complement of heart rate data from these participants, which was limited due to technical issues, could have been used to evaluate internal load, thereby providing an additional measure of exercise intensity.

The related implications of exercise adherence concerning affective response, modality, frequency, and intensity warrants continued research. Overall, this study highlights the potential for new approaches to exercise design and a number of follow-up studies focused on better defining differences in upper and lower body exercise. Future studies should aim to strengthen these protocols with long term training sessions across a larger sample size and with specific evaluation of PACES subscales.

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APPENDIX A: IRB APPROVAL LETTER

UCF

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

APPROVAL

October 9, 2019

Dear David Fukuda:

On 10/9/2019, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title:	Upper body and lower body cycling fatigue thresholds
Investigator:	David Fukuda
IRB ID:	STUDY00000923
Funding:	None
Grant ID:	None
IND, IDE, or HDE:	None
Documents Reviewed:	• Cognitive and enjoyment values tests, Category: Test Instruments; • HRP-502-Consent Document_Up&LoFiT_V2, Category: Consent Form; • HRP-503-Protocol_Up&LoFiT, Category: IRB Protocol; • Medical and Activity History Questionnaire Up&LoFiT, Category: Survey / Questionnaire; • Recruitment Documents_Up&LoFiT, Category: Recruitment Materials; • Up & Lo FiT Study Informed Consent.mp4, Category: Recruitment Materials;

The IRB approved the protocol on 10/9/2019.

In conducting this protocol, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Page 1 of 2

Racine Jacques, Ph.D.
Designated Reviewer

APPENDIX B: TABLES AND FIGURES

Table 1. Physical Activity Enjoyment Scale (PACES).

Item #: Category	**Item**
1	I enjoy it; I hate it
2	I feel bored; I feel interested
3	I dislike it; I like it
4	I find it pleasurable; I find it unpleasurable
5	I am very absorbed in this activity; I am not at all absorbed in this activity
6	It's no fun at all; It's a lot of fun
7	I find it energizing; I find it tiring
8	It makes me depressed; It makes me happy
9	It's very pleasant; It's very unpleasant
10	I feel good physically while doing it; I feel bad physically while doing it
11	It's very invigorating; It's not at all invigorating
12	I am very frustrated by it; I am not at all frustrated by it
13	It's very gratifying; It's not at all gratifying
14	It's very exhilarating; It's not at all exhilarating
15	It's not at all stimulating; It's very stimulating
16	It gives me a strong sense of accomplishment; It does not give me any sense of accomplishment
17	It's very refreshing; It's not at all refreshing
18	I felt as though I would rather be doing something else; I felt as though there was nothing else I would rather be doing

Table 2. PACES total score and power output, time, and feeling scale values at the ventilatory threshold (VT) and maximal aerobic power (MAP). Values are mean ± SD.

	Lower Body	Upper Body
PACES Total	5.8 ± 0.7	5.4 ± 0.8
Power output at MAP (W)	226.3 ± 44.1†	133.7 ± 41.7
Time (s)	744.1 ± 185.9†	916.9 ± 108.7
Feeling Scale at MAP	1.7 ± 2.2	1.5 ± 3.2
Power output at VT (W)	107.1 ± 43.0†	59.1 ± 15.2
% of MAP	46.2 ± 11.6	45.8 ± 11.7
Time (s)	479.3 ± 160.6	577.7 ± 71.3
Feeling Scale at VT	2.9 ± 1.6	3.9 ± 1.1

†significantly different from upper body.

Figure 1: PACES Subscales

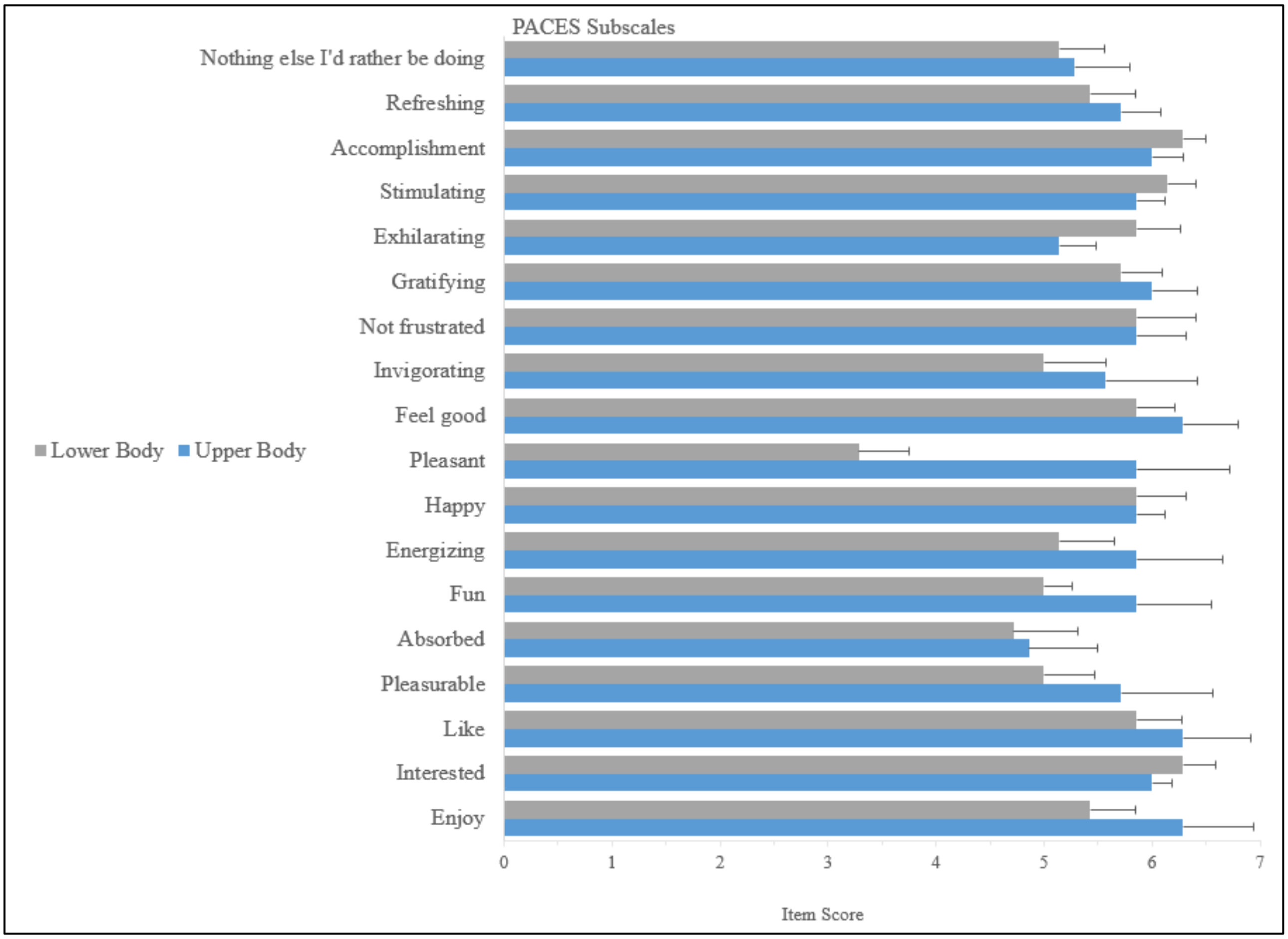

Figure 2: Upper Body Feeling Scale.

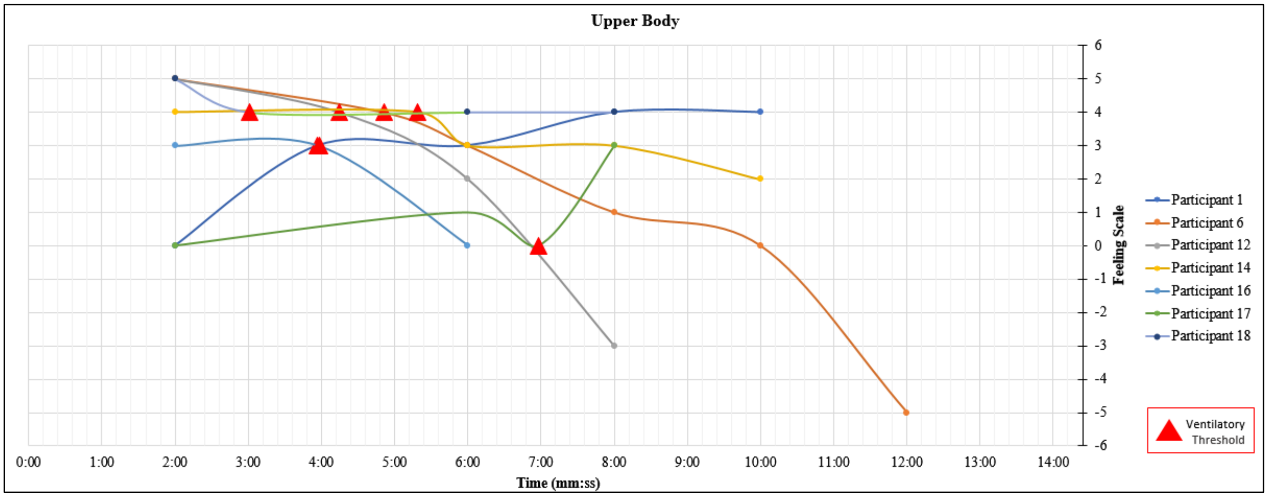

Figure 3: Lower Body Feeling Scale.