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ScienceDirect

Procedia Engineering 112 (2015) 256 – 261

Procedia Engineering

www.elsevier.com/locate/procedia

7th Asia-Pacific Congress on Sports Technology, APCST 2015

Attitudes towards physical activity and perceived exertion in three different multitask cybercycle navigational environments

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Abstract

Physical activity and positive health behaviors are not usually associated with playing video games. Participating in exergames, video games that combine exercise and virtual environments may encourage physical activity by making it more enjoyable. The investigation aimed to study attitudes toward physical activity and perceived exertion in three different multitask cybercycle navigational environments. A sample of 56 adults participated in one of three navigation tasks while riding a stationary bicycle with an interactive computer-based simulation program displayed on the built-in screen. Subjects were randomly assigned one of the three navigation groups: Gauges Monitoring (n=18), Touring (n=19) and Gaming (n=19). After completing the ride and concurrent multitask tests, an attitude survey questionnaire was administered concerning individuals' perceptions of the experience and toward exercise in general. Post-ride participants were also asked to rate their perceived exertion during the ride using the Borg Scale of Perceived Exertion. Analysis of variance tests were used to compare the results among the three groups and between genders on each factor and on the Borg Scale of Perceived Exertion. Significant differences were found for interaction between environment and gender for the Physical Activity factor (P = 0.020), a gender effect for the Walk Skills factor (P = 0.007), and for the Borg Scale (P = 0.004). Subsequent post hoc Tukey tests indicated that the perceived exertion was higher in the Gaming Group when compared with Gauges Monitoring and Touring Groups (P = 0.006; 0.014, respectively). Overall, participants enjoyed the activity irrespective of environment. Results support the proposition that exergaming in light-to-moderate exercise conditions is perceived as being physically active.

Peer-review under responsibility of the the School of Aerospace, Mechanical and Manufacturing Engineering, RMIT University

Keywords: Multitasking; Exergaming; Navigation; Attention; Virtual Reality; Bicycling

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Peer-review under responsibility of the the School of Aerospace, Mechanical and Manufacturing Engineering, RMIT University
doi:10.1016/j.proeng.2015.07.238

1. Introduction

Engaging in adequate physical activity is considered an essential component for providing health benefits [1]. However, the epidemic of sedentary lifestyle can play an important role in contributing to medical problems and is still a concern for the majority of people in developed countries [2]. Recent public health strategies for the prevention of sedentary lifestyles are focusing on habitual behaviors that are integral in an individual's everyday life. This public policy and programmatic context present some new research opportunities and challenges for exercise and sport sciences.

Specifically, clinicians and practitioners have been challenged to develop cost-effective and attractive lifestyle interventions that target the 'inadequately active' or 'completely inactive' segments of the population. Recently, there has been an emergence of active video gaming, or exergaming, which provides physical activity interaction with the player. Such video games are relatively inexpensive and provide active challenges in safe and fun environments [3].

Although physical activity and positive health behaviors are not usually associated with playing video games, exergaming may encourage physical activity by making it more enjoyable by engaging participants with different environments [4]. A more complete understanding of how environmental factors act to determine physical activity behavior would contribute important knowledge to the field, but requires a research effort of considerable scope and complexity [5].

It has been theorized that self-presence in a computer-mediated environment influences one's body-related perceptions and behaviors as well as one's general well-being [6]. The purpose of this investigation was to study people's attitudes toward physical activity and perceived exertion in three different multitask cybercycle navigational environments.

2. Methods

2.1. Participants

In this study, a convenience sample of 56 adults aged 18-79 years was used. Only participants who reported no health or cardiovascular problems or physical limitations that would be made worse by participating in interactive task, were included in the trials (n = 56). Two thirds of the participants were male (n=36) with a mean age of 42.17 (SD=17.31) and one third were female (n=20) with a mean age of 38.87 (SD= 17.37). Participants were recruited from University of Calgary and by email requests that were sent to professional and business networks patronized by investigators. The sample size was calculated with α=0.05, β=0.20, power = 0.80, range = 42, σ = 10.5, Δ = 10. The protocol was approved by the university's Institutional Review Board.

The participants were randomly assigned to three groups of cybercycle navigational environments: peddling while monitoring performance gauges (Gauges, n=18); peddling while navigating a virtual tour (Touring, n=19); and peddling while engaged in a chasing game (Gaming, n=19).

2.2. Procedure

After signing an informed consent, each participant had an individual session to peddle the cybercycle. The Expresso Interactive Upright Exercise Bike, Model S3U (Figure 1) was chosen for this study because of its ease of usage and accessibility.

Figure 1. Expresso Interactive Upright Exercise Bike, Model S3U

A monitor is tightly integrated with the Expresso Upright Exercise Bike and a second monitor was attached to a rectangular board such that it would dangle immediately above the lower monitor. The expresso monitor can display graphical, virtual reality representations of gauges, cycling tours and a fantasy dragon chase game. The virtual position, pace and virtual objects varied with interaction between the Expresso Bike and its user.

It is possible to simultaneously display television images and cycle gauges. The television mode was used to display the virtual gauges (Figure 2). During trials, the television portion of the screen was left blank while images of the gauges were displayed on the margins.

Gauges mode	Touring Mode	Virtual Game Mode

Figure 2. Virtual Images on Expresso Bike monitor in three modes.

The navigation goal task for participants of the Gauges Group was to ride consistently within ±1 mile per hour of a pace that they found comfortable. The Gauges Group participants focused on the speed gauge in particular. Participants from the Touring Group were asked to stray to the furthest edge of the road and, in the Gaming Group, participants had to cease to follow either a yellow arrow, dragon, coin or lantern. A simulated steering and gearing of the cycle were provided for the last two groups.

This study is part of a larger study that looked at multitask while cycling, so all participants from the three groups were requested to respond to a computerized version of the operation span (OSPAN) task in the second monitor, as a distractor from their main activity.

After completing the ride and concurrent multitask tests, participants completed an attitude survey questionnaire consisting of twenty 5-point, Likert scale items, ranging from strongly disagree to strongly agree, concerning the individual's perceptions of the experience and toward exercise and technology in general. Post-ride participants were also asked to rate their perceived exertion during the ride against the Borg Scale of Perceived Exertion.

2.3. Statistical Analysis

A varimax rotation factor analysis of the 20 items of the attitude questionnaire was conducted to determine the number of factors produced. All items with a loading higher than 0.50 on a factor were summarized into one construct. Analysis of Variance (ANOVA) and Tukey's post hoc tests were used to compare the results among the three groups and between genders on each factor and on the Borg Scale of Perceived Exertion. Differences were considered significant when $P < .05$.

3. Results

The varimax rotation factor analysis of the attitude questionnaire yielded six factors that were labeled as Virtual Touring (VT), Physical Activity (PA), Walk Skills (WS), Communication (CC), Video Game (VG) and Exertion (EX) (See Table 1).

Table 1. The table gives the Attitudes' Questionnaire questions and their respective factor and loading

Item	Question	Factor	Loading
A01	I feel very positive generally about virtual reality touring with an exercycle.	VT	0.856
A02	I feel positive about actively interacting as a type of exercise.	VT	0.888
A03	I feel positive about using virtual touring with an exercycle as part of an exercise class.	VT	0.825
A04	I would like to be able to virtual tour with an exercycle at home.	VT	0.598
A05	I am active on a regular basis by walking or exercising.	PA	0.547
A06	I walk regularly in the summer, but avoid walking outside in the winter.	WS	0.757
A07	It is important for me to keep physically active.	PA	0.600
A08	I am worried about falling when I walk.	WS	0.669
A09	Playing video games interests me.	VG	0.920
A10	When I was younger I was a good athlete.	PA	0.769
A11	I generally have a sedentary (not physically active) lifestyle.	PA	-0.679
A12	I currently use a cell phone for communication.	CC	0.848
A13	have a SMART phone that I use for a variety of activities such as keeping a calendar or text messaging as well as making and receiving phone calls.	CC	0.870
A14	Walking outside in the winter concerns me.	WS	0.863
A15	I have always had good balance.	VT	0.709
A16	If someone showed me how to play a video game, I would be interested in trying it.	VG	0.737
A17	I think I can improve my balance with customized exercise.	VT	0.577
A18	Exercising with friends is the best way to keep active.	EX	0.727
A19	Generally I exercise by myself.	EX	0.697
A20	Physical Education was one of my favorite classes in school.	PA	0.814

VT = Virtual Touring; PA = Physical Activity; WS = Walk Skills; CC = Communication; VG = Video Game; EX = Exertion

The ANOVA showed a significant interaction between type of activity and gender for the Physical Activity factor (P = 0.020) and a gender effect for the Walk Skills factor (P = 0.007). Table 2 shows the means and standard deviations for type of activity by gender.

Table 2. Mean and standard deviation of attitude questionnaire factors for the three groups by gender

	Groups											
	Gauges				Touring				Gaming			
	Male		Female		Male		Female		Male		Female	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Virtual Touring	21.53	7.45	21.20	2.38	24.63	2.65	21.12	2.41	23.41	2.15	22.71	2.42
Physical Activity	18.07	4.85	19.00	6.96	22.09	1.75	14.87	2.90	19.41	5.21	18.85	3.97
Walk Skills	6.23	3.32	8.80	2.77	6.18	2.44	9.12	4.01	6.75	2.13	8.14	2.11
Communication	8.53	2.81	8.20	1.48	8.72	1.34	7.50	2.39	7.33	2.90	8.28	2.92
Video Game	6.69	3.22	6.20	2.77	7.18	1.25	6.37	2.38	7.50	2.39	7.15	2.03
Exertion	7.07	2.72	7.20	0.83	7.63	1.12	7.25	1.48	7.16	0.93	11.71	2.06

SD = Standard Deviation

Significant differences were also found for the Borg Scale (P = 0.004). Subsequent post hoc Tukey tests indicated that the perceived exertion was higher in the Gaming Group when compared with the Gauges and the Touring Groups, P = 0.006 and P = 0.014, respectively (see Table 3).

Table 3. Mean and standard deviation of the Borg Scale of Perceived Exertion's results for the three groups

Group	Mean	SD
Gauges	11.59	2.671
Touring	11.82	1.704
Gaming	13.86	0.663
Total	12.33	2.127

4. Discussion and Conclusion

In the current study participants were able to perform physical activity peddling in different environments. Past research has demonstrated the relationship between physical activity behaviors and their potential environmental determinants [7, 8]. According to Roemmich et al. [9], providing opportunities to engage in game environments while exercising can increase the autonomy and enhance intrinsic motivation to keep engaging in general physical activity. In their study, providing participants with autonomy to choose in which environment they wanted to exercise increased the duration and intensity of physical activity, especially for women. When presented with no choice, women were neither as active for as long nor as intensely as men. Other studies have shown that women are typically less active than men [10, 11]. However, if women are provided with a choice of exergaming they can be motivated to engage in physical activity equal to men. Our findings showed mixed results under the physical activity in different environments with Men on average indicating that they were more active in the Gauges and Gaming groups but women on average being more physically active in the Touring group. This is probably artifact of the data because of the number of analyses. Men were also more concerned about falling that may be an age issue.

Kraft et al. [12] found that the use of exergames to exercise was as effective as traditional exercise. Their results indicate that a 'video game interactive bicycle ergometer' was the most effective means of exercise compared to a commercial dance exergame and traditional cycle ergometer. Also, Warburton et al. [13] reported higher heart rate, energy expenditure, and oxygen consumption during exergaming when compared to matched workloads during stationary cycling. Others previous research have shown that exergames are capable of stimulating exercise in accordance with the American College of Sports Medicine (ACSM) recommendations [14, 15]. Our results suggest

that participants enjoyed participating on the exergaming bike. They also perceived that they were working harder in the exergaming environment compared with the other two groups.

Additional supports for the use of active games as a means by which to meet the ACSM's recommendations for physical activity include the ability to exercise in the home, especially for those with low self-confidence, and participants' attraction to video games as opposed to traditional forms of exercise. It has been shown that immediate satisfaction can be improved through the selection of enjoyable exercise activities. Research suggests that incorporating the use of exergames or game-based activities into routine training may be an option for increasing the duration and quality of physical activity and aid in reversing inactivity.

Overall, the present study showed that participants enjoyed the activity irrespective of the environment in which they were recruited. Our results support the proposition that exergaming in light-to-moderate exercise conditions is perceived as being physically active.

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