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Original Article

Development of A Teen-Focused Exergame

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Abstract

Introduction: Exergames require body movement to play and may be an effective method for enhancing teen physical activity (PA). However, results have been mixed. Innovative methods are needed to develop Exergames that increase and maintain PA. Self-representational avatars, or avatars created from a digital image of an individual, may increase PA (e.g., intensity, duration) during Exergame play. This article addresses this novel idea by describing the development of an Exergame played with a self-representational avatar.
Materials and Methods: Twelve- to 14-year-olds, stratified by gender, body mass index, and PA, were invited to participate in two rounds of data collection. Each round consisted of an online survey, followed by a telephone interview to ensure comprehension of survey responses. After the first round, an Exergame prototype and the system for creating the self-representational avatar were created. A second round of data was collected to obtain information with which to create a fully functional Exergame and the avatar creation system.
Results: Forty-eight teens were recruited. The sample was multi-ethnic (41.7% White, 37.5% Black, 18.8% Hispanic, 2.1% Mixed/Other). Complete data were obtained on 48 teens in the first round of data collection and on 43 teens in the second round. Teens provided important information regarding preferences and expectations. Gender similarities and differences were observed.
Conclusion: This research contributes to the body of knowledge regarding how to design an appealing Exergame for teens navigated by a self-representational avatar.

Keywords: Physical activity, Virtual world, Exergame, Avatars, Self Determination Theory, Adolescents

Introduction

Prevalence of type 2 diabetes in youth is increasing at an alarming rate.[1] Obesity, a primary risk factor for type 2 diabetes,[2] is high among youth.[3] Physical activity (PA) is the major modifiable component of energy expenditure[4] and has been associated with lower body fat in children.[5] PA typically decreases from childhood through adulthood.[6] Adolescents seem to be a particularly at-risk group, with substantial decreases in PA observed during this period.[7] Thus, finding effective methods for increasing PA during adolescence should reduce risk of obesity[8,9] and, in turn, risk of type 2 diabetes.[2] To achieve this, it is important to encourage PA in a manner that is enjoyable, motivational, and sustainable.

Videogames are a highly appealing form of entertainment for youth,[10] particularly when played in a virtual world where the player assumes the identity of an avatar.[11–13] Serious videogames have the dual purpose of both entertaining and changing behavior.[14,15] Exergames are a type of serious videogame that requires the player to move his or her body to play the game.[16] Because Exergames require bodily movement, they could be a fun and motivational method for encouraging youth to be more physically active. However, results of their effectiveness have been mixed,[16–18] demonstrating a need to investigate ways in which to design Exergames that encourage longer and more intense gameplay and, therefore, increased PA.

Exergames often use an avatar to represent the player in the virtual world.[19] Emerging evidence suggests that the avatar's appearance may be a key factor influencing their effect on player behavior[20] in both men and women.[21,22] Because players often identify with their avatar,[19,23] particularly when the avatar is perceived as similar,[24] it is likely that navigating an Exergame with a highly self-representational avatar (i.e., one that closely resembles the player) would be a powerful motivator, possibly leading to greater engagement and PA during gameplay. For example, research suggests that players were willing to perform PA when confronted with situations in a virtual world where their actions affected their avatar, particularly when the avatar's appearance was similar to theirs.[24]

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Self Determination Theory (SDT)[25] provides a theoretical framework for understanding the relationship between an avatar and the player's effort or engagement in a virtual world.[26] SDT posits that behavior is motivated by three basic psychological needs: autonomy (choice, control), competence (skill, ability), and relatedness (connection to self and important others).[25] The greater the degree to which these needs are met, the greater the autonomous (i.e., self-driven) motivation to perform the behavior. Further, by casting the player as a ''hero'' in the virtual world,[26] the avatar makes choices (autonomy) that overcome obstacles or dangers (competence), thus making the virtual world a better place for its inhabitants (relatedness). Partnering with teens during development of an Exergame can help identify ideal ways to accomplish this in an appealing and acceptable manner.[27]

This article describes the development of an SDT-grounded Exergame played in a virtual world with a self-representational (i.e., photorealistic) avatar, and a system for creating the avatar. The research reported here was guided by two aims:

Aim 1: Develop an immersive PA game specifically for youth.

Aim 2: Develop a photorealistic personalized avatar creation system.

The purpose of this research is to contribute to the body of knowledge regarding how to design Exergames that appeal to teens.

Materials and Methods

Participants

Eligible participants were 12–14 year-olds who were fluent in English and who had an email address. To ensure that a broad range of perspectives and abilities were represented, teens were stratified by a self-report of gender (male, female), PA level (PA <60 minutes/day five times/week, PA $\geq$60 minutes/day five times/week), and BMI (<85th percentile, $\geq$85th percentile), based on the 2000 CDC age and gender specific growth charts.[28] Forty-eight teens who met the inclusionary criteria participated in this phase. Based on previous experience in developing behavior change programs for children and teens,[29] this sample size was expected to provide adequate information with which to develop and refine the Exergame and avatar creation system.

Recruitment

Teens were recruited by using the volunteer database at the Children's Nutrition Research Center and other standard recruitment methods (e.g., newsletter and website announcements, distribution of flyers in community locations likely to be visited by parents and teens). Institutional review board approval was obtained from the University of Houston (12549-01) and the Baylor College of Medicine (H-31426). Written parental consent and assent were obtained before participation in data collection activities.

Data collection

Two rounds of data collection were conducted. Each round consisted of an online survey, followed by a telephone interview. The online survey was hosted on a secure, password-protected website. Teens were provided with a private password with which to complete the survey. After completion of the survey, teens were contacted by trained study staff to schedule a telephone interview. Scripted, semi-structured interviews were guided by the teen's survey responses. Surveys included multiple-choice and open-ended questions. During the interview, the participants were reminded of the survey questions and their responses; responses were then discussed (e.g., ''Tell me your reasons for selecting this answer''). Probes and prompts were used as needed to clarify and understand their responses. Interviews were digitally recorded. For the purposes of this article, survey results are reported for responses to multiple-choice questions that informed game development. Teens received a $50 money order after completing each round of data collection.

This research was guided by a conceptual model grounded in SDT (Fig. 1). The first round of data collection obtained information on teen preferences regarding videogames and avatars. For example, in the initial survey, teens were asked ''What types of videogames do you like? (check all that apply); response options ranged from Action/Adventure to Casual (e.g., Solitaire) (note: see Table 2 for a complete listing); during the interview, the interviewer said ''You said you like playing these types of videogames [insert answer]. What do you like about playing these videogames?'' Information from the first round of data collection was used to generate ideas for the Exergame (e.g., genre, storyline, actions) and the photorealistic avatar creation system. The second round of data collection generated information with which to refine design decisions. For example, in the second survey, teens were asked to rate features of the ''Flying Carpet'' prototype on a 5-point scale ranging from ''dislike a lot'' to ''like a lot''; during the interview, teens were reminded of their response to each feature and asked their reasons for selecting that response.

Statistical analysis

Descriptive statistics were calculated for the survey data. Similar to the analytic approach used in the HEALTHY Study,[30] interviewers created a summary of key points that emerged during the interviews. They presented the emerging summary at the weekly staff meeting where it was discussed, clarified, and refined. Interviewers also met separately throughout the interview process to discuss the interviews and the emerging findings and to further refine the emerging summary. At the end of each round of data collection, interviewers met to discuss their findings and to create final summary of key points that emerged from the interviews. The summaries were used to clarify and enhance understanding of survey responses and to provide additional insight into participant reactions and suggestions.

Results

Teens ($n=48$) were evenly divided by gender and PA, as indicated by the *a priori* stratification criteria. An exception was noted with BMI. One participant was misclassified during recruitment, resulting in slightly fewer participants with a BMI of $\geq$85th percentile ($n=25$ BMI <85th percentile; $n=23$ BMI $\geq$85th percentile). Although race/ethnicity was not a stratification criterion, the sample was multi-ethnic (41.7% White, 37.5% Black, 18.8% Hispanic, 2.1% Mixed/Other).

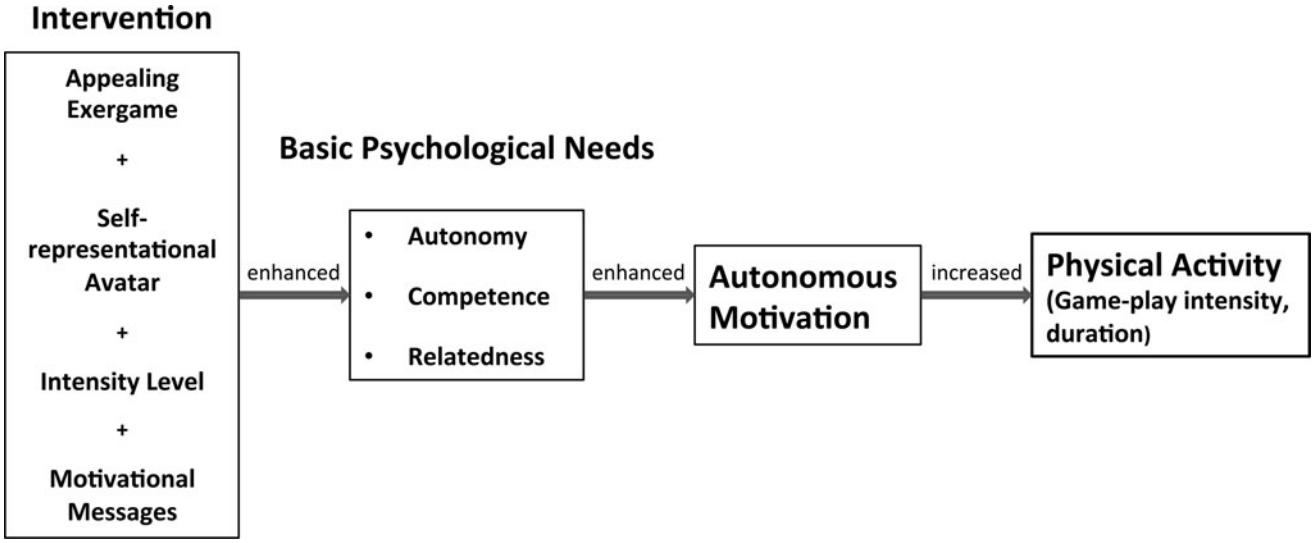

FIG. 1. Conceptual model.

Complete data were obtained on 48 teens in the first round of data collection and on 43 teens in the second round (Table 1).

Round 1 results

Teens reported playing videogames with varying frequency (Table 2). Some played daily (25.0%), whereas others played only occasionally (22.9%). Most had been playing for more than 3 years (72.9%). Frequently reported family rules regarding videogame play related to how often they play (60.4%), when they play (56.3%), and the amount of time they spend playing (54.2%).

Common game-play formats were game consoles (87.5%) and cell/smartphones (75.0%); less common formats included desktop computers/laptops (47.9%) and iPad/tablets (47.9%). The top five types of videogames liked by teens were action/adventure (83.3%), sports (70.8%), racing (68.8%), fighting (56.3%), and puzzle/strategy (50.0%). Those receiving the lowest ratings were casual (33.3%), educational (27.1%), and sandbox (14.6%). Teens played videogames with a variety of ratings; the most common was ''Teen'' (68.8%), followed closely by ''Everyone'' (64.6%), ''Everyone 10+'' (60.4%), and ''Mature'' (52.1%).

Table 1. Descriptive Statistics for Demographic Characteristics ($N=48$)

Gender, *n* (%)	
Male	24 (50.00)
Female	24 (50.00)
BMI group, *n* (%)	
<85th percentile	25 (52.08)
≥85th percentile	23 (47.92)
Physical activity (≥60 minutes/day), *n* (%)	
<5 days/week	24 (50.00)
≥5 days/week	24 (50.00)
Race, *n* (%)	
White	20 (41.67)
African American	18 (37.50)
Hispanic	9 (18.75)
Mixed/Other	1 (2.08)

When asked how they felt about playing videogames alone, 22.9% said it was their favorite way to play. Alternatively, 33.3% said playing competitively played games was their favorite way to play. Only 14.6% said playing cooperatively played games was their favorite way to play. Some teens reported that their favorite way to play was all three ways (29.2%).

A wide variety of game features were viewed as ''very important'' by teens overall, with 50% or more reporting that gameplay (77.1%), controllable avatar or game character (60.4%), customizable characters (56.3%), story (56.3%), graphics (52.1%), and genre (50.0%) were ''very important.'' Those rated as ''very important'' by fewer than 50% of teens were cut scenes (14.6%), quests (22.9%), points (31.3%), soundtrack (31.3%), character diversity (31.3%), scoreboard (31.1%), exploration (33.3%), increasing difficulty (39.6%), interactivity (41.7%), character development (41.7%), animation (43.8%), action speed/frames per second (45.8%), and challenge (47.9%).

Teens also thought it was ''very important'' to customize their avatar (41.7%). Features they wanted to customize were body (95.8%), clothing (93.8%), hair color/style/texture (87.5%), eye color (79.2%), accessories (79.2%), skin tone (77.1%), and facial features (72.9%).

Consistent with other research on videogame play,[31] gender differences were observed. Men were more likely than women to report playing videogames daily (37.5% men; 12.5% women) or several times a day (16.7% men; 0.0% women); whereas women were more likely than men to report playing videogames ''almost never'' (33.3% women; 0.0% men). Men were also more likely than women to report playing videogames for more than 3 years (87.5% men; 58.3% women).

Similarities and differences were observed in the top five videogames liked by men and women. The top five videogames liked by men were action/adventure (95.8%), racing (87.5%), sports (79.2%), fighting (79.2%), and survival/horror survival (66.7%). Alternatively, the top five videogames liked by women were action/adventure (70.8%), dance/rhythm/

Table 2. Descriptive Statistics for Survey 1 Overall and by Gender ($N=48$)

	Total (n=*48*), n *(%)*	*Male* (n=*24*), n *(%)*	*Female* (n=*24*), n *(%)*
Frequency of game-play			
Several times a day	4 (8.3)	4 (16.7)	0 (0.0)
Daily	12 (25.0)	9 (37.5)	3 (12.5)
Several times a week	7 (14.6)	3 (12.5)	4 (16.7)
Occasionally	11 (22.9)	6 (25.0)	5 (20.8)
Only on weekend or holiday	6 (12.5)	2 (8.3)	4 (16.7)
Almost never	8 (16.7)	0 (0.0)	8 (33.3)
Length of gameplay			
Less than 1 year	2 (4.2)	0 (0.0)	2 (8.3)
1–2 years	3 (6.3)	0 (0.0)	3 (12.5)
2–3 years	8 (16.7)	3 (12.5)	5 (20.8)
>3 years	35 (72.9)	21 (87.5)	14 (58.3)
Family rules (yes/no)			
The types of videogames you can buy or download			
Yes	22 (45.8)	12 (50.0)	10 (41.7)
No	26 (54.2)	12 (50.0)	14 (58.3)
The types of videogames you can play			
Yes	22 (45.8)	12 (50.0)	10 (41.7)
No	26 (54.2)	12 (50.0)	14 (58.3)
The ratings of the videogames you can play (e.g., E for Everyone, T for Teen)			
Yes	20 (41.7)	6 (25.0)	14 (58.3)
No	28 (58.3)	18 (75.0)	10 (41.7)
When do you play videogames?			
Yes	27 (56.3)	16 (66.7)	11 (45.8)
No	21 (43.8)	8 (33.3)	13 (54.2)
How often do you play videogames?			
Yes	29 (60.4)	16 (66.7)	13 (54.2)
No	19 (39.6)	8 (33.3)	11 (45.8)
Who can you play videogames with?			
Yes	13 (27.1)	5 (20.8)	8 (33.3)
No	35 (72.9)	19 (79.2)	16 (66.7)
Where can you play videogames?			
Yes	16 (33.3)	6 (25.0)	10 (41.7)
No	32 (66.7)	18 (75.0)	14 (58.3)
How much time can you spend playing videogames?			
Yes	26 (54.2)	13 (54.2)	13 (54.2)
No	22 (45.8)	11 (45.8)	11 (45.8)
Usual ways of playing videogames (check all that apply)			
Desktop computer/laptop	23 (47.9)	13 (54.2)	10 (41.7)
Cell/smartphone	36 (75.0)	17 (70.8)	19 (79.2)
Game console (e.g., Wii™, Xbox®, Playstation, etc.)	42 (87.5)	24 (100.0)	18 (75.0)
iPad/Tablet	23 (47.9)	13 (54.2)	10 (41.7)
Other	2 (4.2)	1 (4.2)	1 (4.2)
Type of videogames you like (check all that apply)			
Action/Adventure	40 (83.3)	23 (95.8)	17 (70.8)
Family Entertainment	20 (41.7)	9 (37.5)	11 (45.8)
Role Playing (RPG)	20 (41.7)	13 (54.2)	7 (29.2)
Survival/Horror Survival	21 (43.8)	16 (66.7)	5 (20.8)
Puzzle/Strategy	24 (50.0)	10 (41.7)	14 (58.3)
Simulation	20 (41.7)	11 (45.8)	9 (37.5)
Sandbox	7 (14.6)	7 (29.2)	0 (0.0)
Racing	33 (68.8)	21 (87.5)	12 (50.0)
Sports	34 (70.8)	19 (79.2)	15 (62.5)
Fighting	27 (56.3)	19 (79.2)	8 (33.3)
Dance/Rhythm/Active	23 (47.9)	6 (25.0)	17 (70.8)
Educational	13 (27.1)	8 (33.3)	5 (20.8)
Casual (e.g., Solitaire)	16 (33.3)	6 (25.0)	10 (41.7)
Other	6 (12.5)	5 (20.8)	1 (4.2)

(*continued*)

TABLE 2. (CONTINUED)

	Total (n=*48*), n *(%)*	*Male* (n=*24*), n *(%)*	*Female* (n=*24*), n *(%)*
Play-style preferences			
Alone (reversed)			
1-	9 (18.8)	4 (16.7)	5 (20.8)
2-	13 (27.1)	9 (37.5)	4 (16.7)
3-	15 (31.3)	7 (29.2)	8 (33.3)
4-Favorite	11 (22.9)	4 (16.7)	7 (29.2)
With others competitively (reversed)			
1-	6 (12.5)	4 (16.7)	2 (8.3)
2-	12 (25.0)	6 (25.0)	6 (25.0)
3-	14 (29.2)	7 (29.2)	7 (29.2)
4-Favorite	16 (33.3)	7 (29.2)	9 (37.5)
With others cooperatively (reversed)			
1-	12 (25.0)	7 (29.2)	5 (20.8)
2-	14 (29.2)	6 (25.0)	8 (33.3)
3-	15 (31.3)	8 (33.3)	7 (29.2)
4-Favorite	7 (14.6)	3 (12.5)	4 (16.7)
All the ways listed (reversed)			
1-	21 (43.8)	9 (37.5)	12 (50.0)
2-	9 (18.8)	3 (12.5)	6 (25.0)
3-	4 (8.3)	2 (8.3)	2 (8.3)
4-Favorite	14 (29.2)	10 (41.7)	4 (16.7)
Ratings of videogames usually played (check all that apply)			
Everyone	31 (64.6)	14 (58.3)	17 (70.8)
Everyone 10+	29 (60.4)	15 (62.5)	14 (58.3)
Teen	33 (68.8)	20 (83.3)	13 (54.2)
Mature	25 (52.1)	20 (83.3)	5 (20.8)
Other	2 (4.2)	2 (8.3)	0 (0.0)
Importance of videogame features			
Graphics			
1-Not important	4 (8.3)	1 (4.2)	3 (12.5)
2-	2 (4.2)	0 (0.0)	2 (8.3)
3-Neutral	4 (8.3)	2 (8.3)	2 (8.3)
4-	13 (27.1)	7 (29.2)	6 (25.0)
5-Very important	25 (52.1)	14 (58.3)	11 (45.8)
Soundtrack			
1-Not important	5 (10.4)	1 (4.2)	4 (16.7)
2-	6 (12.5)	3 (12.5)	3 (12.5)
3-Neutral	12 (25.0)	7 (29.2)	5 (20.8)
4-	10 (20.8)	5 (20.8)	5 (20.8)
5-Very important	15 (31.3)	8 (33.3)	7 (29.2)
Character development			
1-Not important	3 (6.3)	2 (8.3)	1 (4.2)
2-	1 (2.1)	0 (0.0)	1 (4.2)
3-Neutral	10 (20.8)	2 (8.3)	8 (33.3)
4-	14 (29.2)	7 (29.2)	7 (29.2)
5-Very important	20 (41.7)	13 (54.2)	7 (29.2)
Character diversity			
1-Not important	8 (16.7)	3 (12.5)	5 (20.8)
2-	3 (6.3)	1 (4.2)	2 (8.3)
3-Neutral	13 (27.1)	6 (25.0)	7 (29.2)
4-	9 (18.8)	5 (20.8)	4 (16.7)
5-Very important	15 (31.3)	9 (37.5)	6 (25.0)
Story			
1-Not important	5 (10.4)	2 (8.3)	3 (12.5)
2-	1 (2.1)	0 (0.0)	1 (4.2)
3-Neutral	6 (12.5)	4 (16.7)	2 (8.3)
4-	9 (18.8)	3 (12.5)	6 (25.0)
5-Very important	27 (56.3)	15 (62.5)	12 (50.0)
Avatar or videogame character that you control			
1-Not important	2 (4.2)	0 (0.0)	2 (8.3)
2-	1 (2.1)	0 (0.0)	1 (4.2)

(*continued*)

TABLE 2. (CONTINUED)

	Total (n=*48*), n *(%)*	*Male* (n=*24*), n *(%)*	*Female* (n=*24*), n *(%)*
3-Neutral	5 (10.4)	3 (12.5)	2 (8.3)
4-	11 (22.9)	6 (25.0)	5 (20.8)
5-Very important	29 (60.4)	15 (62.5)	14 (58.3)
Game-play (i.e., what you do in the videogame			
1-Not important	0 (0.0)	0 (0.0)	0 (0.0)
2-	1 (2.1)	0 (0.0)	1 (4.2)
3-Neutral	4 (8.3)	1 (4.2)	3 (12.5)
4-	6 (12.5)	1 (4.2)	5 (20.8)
5-Very important	37 (77.1)	22 (91.7)	15 (62.5)
Interactivity			
1-Not important	4 (8.3)	1 (4.2)	3 (12.5)
2-	3 (6.3)	0 (0.0)	3 (12.5)
3-Neutral	11 (22.9)	6 (25.0)	5 (20.8)
4-	10 (20.8)	7 (29.2)	3 (12.5)
5-Very important	20 (41.7)	10 (41.7)	10 (41.7)
Genre			
1-Not important	5 (10.4)	2 (8.3)	3 (12.5)
2-	1 (2.1)	0 (0.0)	1 (4.2)
3-Neutral	7 (14.6)	3 (12.5)	4 (16.7)
4-	11 (22.9)	5 (20.8)	6 (25.0)
5-Very important	24 (50.0)	14 (58.3)	10 (41.7)
Animation			
1-Not important	1 (2.1)	1 (4.2)	0 (0.0)
2-	6 (12.5)	1 (4.2)	5 (20.8)
3-Neutral	7 (14.6)	2 (8.3)	5 (20.8)
4-	13 (27.1)	7 (29.2)	6 (25.0)
5-Very important	21 (43.8)	13 (54.2)	8 (33.3)
Action speed/Frames per second			
1-Not important	7 (14.6)	2 (8.3)	5 (20.8)
2-	3 (6.3)	1 (4.2)	2 (8.3)
3-Neutral	9 (18.8)	4 (16.7)	5 (20.8)
4-	7 (14.6)	4 (16.7)	3 (12.5)
5-Very important	22 (45.8)	13 (54.2)	9 (37.5)
Cut scenes			
1-Not important	12 (25.0)	2 (8.3)	10 (41.7)
2-	11 (22.9)	9 (37.5)	2 (8.3)
3-Neutral	12 (25.0)	6 (25.0)	6 (25.0)
4-	6 (12.5)	4 (16.7)	2 (8.3)
5-Very important	7 (14.6)	3 (12.5)	4 (16.7)
Challenge			
1-Not important	3 (6.3)	3 (12.5)	0 (0.0)
2-	2 (4.2)	1 (4.2)	1 (4.2)
3-Neutral	7 (14.6)	3 (12.5)	4 (16.7)
4-	13 (27.1)	5 (20.8)	8 (33.3)
5-Very important	23 (47.9)	12 (50.0)	11 (45.8)
Increasing difficulty			
1-Not important	3 (6.3)	3 (12.5)	0 (0.0)
2-	1 (2.1)	0 (0.0)	1 (4.2)
3-Neutral	12 (25.0)	7 (29.2)	5 (20.8)
4-	13 (27.1)	6 (25.0)	7 (29.2)
5-Very important	19 (39.6)	8 (33.3)	11 (45.8)
Points			
1-Not important	9 (18.8)	4 (16.7)	5 (20.8)
2-	5 (10.4)	4 (16.7)	1 (4.2)
3-Neutral	9 (18.8)	5 (20.8)	4 (16.7)
4-	10 (20.8)	4 (16.7)	6 (25.0)
5-Very important	15 (31.3)	7 (29.2)	8 (33.3)
Quests			
1-Not important	9 (18.8)	4 (16.7)	5 (20.8)
2-	5 (10.4)	2 (8.3)	3 (12.5)
3-Neutral	8 (16.7)	3 (12.5)	5 (20.8)

(*continued*)

TABLE 2. (CONTINUED)

	Total (n=*48*), n *(%)*	*Male* (n=*24*), n *(%)*	*Female* (n=*24*), n *(%)*
4-	15 (31.3)	9 (37.5)	6 (25.0)
5-Very important	11 (22.9)	6 (25.0)	5 (20.8)
Scoreboard			
1-Not important	12 (25.0)	7 (29.2)	5 (20.8)
2-	5 (10.4)	2 (8.3)	3 (12.5)
3-Neutral	13 (27.1)	5 (20.8)	8 (33.3)
4-	3 (6.3)	2 (8.3)	1 (4.2)
5-Very important	15 (31.3)	8 (33.3)	7 (29.2)
Exploration			
1-Not important	6 (12.5)	2 (8.3)	4 (16.7)
2-	3 (6.3)	1 (4.2)	2 (8.3)
3-Neutral	7 (14.6)	2 (8.3)	5 (20.8)
4-	16 (33.3)	9 (37.5)	7 (29.2)
5-Very important	16 (33.3)	10 (41.7)	6 (25.0)
Characters that you can customize or create			
1-Not important	5 (10.4)	2 (8.3)	3 (12.5)
2-	6 (12.5)	1 (4.2)	5 (20.8)
3-Neutral	5 (10.4)	3 (12.5)	2 (8.3)
4-	5 (10.4)	4 (16.7)	1 (4.2)
5-Very important	27 (56.3)	14 (58.3)	13 (54.2)
Preferences for customizable avatar features (check all that apply)			
Body (i.e., taller, shorter, etc.)	46 (95.8)	24 (100.0)	22 (91.7)
Eye color	38 (79.2)	18 (75.0)	20 (83.3)
Hair color/style/texture	42 (87.5)	20 (83.3)	22 (91.7)
Skin tone	37 (77.1)	17 (70.8)	20 (83.3)
Clothing	45 (93.8)	21 (87.5)	24 (100.0)
Facial features	35 (72.9)	17 (70.8)	18 (75.0)
Accessories (i.e., sunglasses, jewelry, shoes, etc.)	38 (79.2)	21 (87.5)	17 (70.8)
Other	7 (14.6)	5 (20.8)	2 (8.3)
Importance of customizing avatar			
1-Not important	3 (6.3)	2 (8.3)	1 (4.2)
2-	4 (8.3)	0 (0.0)	4 (16.7)
3-Neutral	8 (16.7)	5 (20.8)	3 (12.5)
4-	13 (27.1)	6 (25.0)	7 (29.2)
5-Very important	20 (41.7)	11 (45.8)	9 (37.5)
Preferred number of characters other than avatar			
1	3 (6.3)	1 (4.2)	2 (8.3)
2	4 (8.3)	3 (12.5)	1 (4.2)
3	12 (25.0)	5 (20.8)	7 (29.2)
4 or more	29 (60.4)	15 (62.5)	14 (58.3)
Importance of having game characters (1=not important—5=very important)			
1-Not important	0 (0.0)	0 (0.0)	0 (0.0)
2-	3 (6.3)	0 (0.0)	3 (12.5)
3-Neutral	4 (8.3)	0 (0.0)	4 (16.7)
4-	14 (29.2)	9 (37.5)	5 (20.8)
5-Very important	27 (56.3)	15 (62.5)	12 (50.0)

active (70.8%), sports (62.5%), puzzle/strategy (58.3%), and racing (50.0%). Among the top five videogames liked by teens overall, gender similarities and differences were also observed. Although action/adventure (95.8% men; 70.8% women), sports (79.2% men; 62.5% women), and racing (87.5% men; 50.0% women) were in the top five for both, the top five videogames liked by women did not include fighting (33.3%), whereas they did for men (79.2%). Alternatively, puzzle/strategy videogames did not make it into the top five for men (41.7%), whereas it did for women (58.3%).

Differences were also seem in gameplay style preferences. When rated separately, women were more likely than men to report playing alone (29.2% women; 16.7% men), playing competitively (37.5% women; 29.2% men), and playing cooperatively (16.7% women; 12.5% men) as their favorite playstyles. Alternately, men appeared to exhibit greater diversity in play-style preferences, with more men (41.7%) than women (16.7%) selecting ''all the ways listed'' as their favorite playstyle.

Although both men and women reported playing videogames with a variety of ratings, several gender differences of note were observed. Men were more likely than women to play videogames rated as ''Teen'' (83.3% men; 54.2% women), ''Mature'' (83.3% men; 20.8% women), and

''Everyone 10+'' (62.5% men; 58.3% women); whereas women were more likely than men to report playing videogames rated as ''Everyone'' (70.8% women; 58.3% men).

The top five game features ranked as ''very important'' by at least 50% of teens overall were generally more important to men than women: gameplay (91.7% men; 62.5% women); controllable avatar or game character (62.5% men; 58.3% women); customizable characters (58.3% men; 54.2% women), story (62.5% men; 50.0% women), graphics (58.3% men; 45.8 women), and genre (58.3% men; 41.7% women).

When examining features rated as ''very important'' separately by gender, both similarities and differences emerged. At least 50% of both men and women rated gameplay (91.7% men; 62.5% women), controllable avatar or game character (62.5% men; 58.3% women), story (62.5% men; 50.0% women), and customizable character (58.3% men; 54.2% women) as ''very important.'' At least 50% of men also ranked graphics (58.3%), genre (58.3%), character development (54.2%), animation (54.2%), action speed/frames per second (54.2%), and challenge (50.0%) as very important; whereas no additional features were rated as ''very important'' by at least 50% of women.

More men (45.8%) than women (37.5%) rated customizing their avatar as ''very important.'' Although some differences were observed in features they would like to customize, the most striking related to body and clothing. All men said they would like to customize the avatar's body'' (100%), whereas all women said they would like to customize the avatar's ''clothing'' (100.0%).

The interviews revealed that teens preferred playing on game consoles because of the larger screen, better graphics, and more game selections. They liked playing on Wii™ or Kinect, because they could be active when playing. They liked playing action/adventure videogames, because they were exciting and had missions and a good story, which made them want to see what happened next. The interviews further revealed teen preferences regarding appropriate Exergame content and focus. For example, when asked what not to include in a videogame, violence, inappropriate language, sexual content, drugs, and revealing clothing were mentioned. All teens thought that childish features such as clowns, silly jokes, kid songs, or challenges that were too simple, and color themes that were too young (bright colors/pastels) should not be included. They also said that educational content should not be included, because they feel tired after a long day of school and do not want to learn anymore. In summary, the quantitative and qualitative results suggested that teens wanted a fun game that challenged them, included active movement to play, and had good graphics, story, and a highly customizable avatar that they could control.

Application of round 1 results

Initial storylines. Based on the initial round of data collection, potential game ideas and components were generated for testing in round 2. Three storylines were developed: *Island Warrior, The Vanishing Island*, and *Operation: Tropical Mystery*. The goal of *Island Warrior* was for the hero to rescue a princess captured by an evil dragon. In *The Vanishing Island*, the hero's goal was to save the island from self-destruction. In *Operation: Tropical Mystery*, as the hero, a stranded government agent, attempts to recover his supplies, the island's dark secrets begin to emerge.

Initial prototype. After the first round of data collection, an initial game prototype was developed and programmed. Given the early stage of this research (i.e., proof of concept) and the finding that teens liked all three play-styles (alone, competitively, cooperatively), a decision was made to create a game played alone. Once proof of concept is established, future studies could expand this research to include other play-styles. The prototype, titled *Flying Carpet*, was designed to enable the player to perform various actions (e.g., kick, jump, squat) in the real world that that their customized avatar simultaneously performed in the virtual game world. The goal was to earn sufficient points to escape a beautiful, but isolated, island within a given time period (Fig. 2). The *Flying Carpet* game prototype was developed by using the three-dimensional (3D) Unity game engine on the Windows platform. The 3D island environment was manually crafted in advance as a game asset. Motion control code was then written by using the C# programming language to control how the avatar moved and responded to various obstacles or attacks in the environment. To connect the tracked Kinect motion signals with the avatar movements in real time, the avatar's skeleton movements were extracted based on the Microsoft Kinect SDK, a toolkit designed by Microsoft to facilitate developers to efficiently write the code for Kinect-based applications. The skeleton movement signals were then transformed to their corresponding pre-built avatar animation clips based on a pre-constructed mapping table that encodes all the possible correspondences between Kinect movement signal segments and avatar animation clips.

Avatar creation system. A method was developed to create a 3D scan of an individual and to then convert the scan into an avatar that could be inserted into the Exergame. The digitized information was processed by using a Maya® plug-in. This plug-in supports many features that allow the user to customize the avatar's visual appearance, bind animation sequences, and provide connections with the game.

Structure Sensor (developed by Occipital, Inc.) with the itSeez3D app on an iPad was used to scan the player and to create a 3D model (Fig. 3, left side). The scanner consisted of a depth camera as well as a regular camera that operated in parallel. We first scanned a rough 3D model of the entire body. Then, scans from different angles were made to generate more geometric details of the body and to fill holes in the scan. A skeleton model was also created to facilitate animation of the avatar in the Kinect game (e.g., making various poses during gameplay). Figure 3 shows the 3D scanning sensor, an example of a scanned model, and two rendered images of the created avatar models (from two different 3D perspectives). Once created, customization features were offered, including shoe type, eyeglasses, hairstyles, and color of these items.

Round 2 results

Teens were asked to rate each of the storylines from most to least favorite. *Operation: Tropical Mystery* was rated ''most favorite'' by 62.8% of teens, followed by *Vanishing Island* (30.2%) and *Island Warrior* (7.0%) (Table 3).

FIG. 2. A runtime snapshot of the flying carpet game prototype.

Teens had favorable reactions to the avatar created by the avatar creation system. They thought the avatar looked a lot like the person it represented (79.1%) and that 30 minutes was an appropriate amount of time to create a self-representational avatar (60.5%). They said they would work ''a little'' (44.2%) or ''a lot'' (37.2%) harder to overcome obstacles or to earn points if they played a game with an avatar that looked like them. Teens liked the idea of navigating a game with this type of an avatar (23.3% liked it a little; 55.8% liked it a lot) and thought the customization options (e.g., eyeglasses, etc.) were ''great'' (46.5%).

When asked to rate the *Flying Carpet* prototype, teens had variable reactions. They liked the scenery (34.9%) and art style (30.2%) ''a lot,'' but reported liking the gameplay video clip (41.9%), island setting (34.9%), castle (32.6%), graphics (30.2%), and color theme (41.9%) ''a little.'' Player actions were rated as ''neither like nor dislike'' by 44.2% of teens, whereas they reported disliking the music ''a little'' (25.6%).

Few gender differences emerged. Women (78.3%) were more likely than men (45.0%) to rate *Operation: Tropical Mystery* as their most favorite storyline. Alternatively, more men (50.0%) than women (13.0%) rated *Vanishing Island* as their most favorite storyline. Men (85.0%) were more likely than women (73.9%) to report that the avatar looked ''a lot'' like the person it represented. Men (45.0%) were also more likely than women (30.4%) to say they would work ''a little'' harder in the videogame if their avatar looked like them,

FIG. 3. This graphic (from left to right) shows the 3D scanning device on an ipad, a model to be scanned, and a graphically rendered image of the created 3D avatar model (side view and back view).

Table 3. Survey 2 Results Overall and by Gender ($N=43$)

	Total (n=*43*), n *(%)*	*Male* (n=*20*), n *(%)*	*Female* (n=*23*), *n (%)*
Storyline rankings: most to least favorite			
Storyline A: Island Warrior			
Most favorite	3 (6.98)	1 (5.00)	2 (8.70)
Favorite	13 (30.23)	7 (35.00)	6 (26.09)
Least favorite	27 (62.79)	12 (60.00)	15 (65.22)
Storyline B: The Vanishing Island			
Most favorite	13 (30.23)	10 (50.00)	3 (13.04)
Favorite	21 (48.84)	8 (40.00)	13 (56.52)
Least favorite	9 (20.93)	2 (10.00)	7 (30.43)
Storyline C: Operation: Tropical Mystery			
Most favorite	27 (62.79)	9 (45.00)	18 (78.26)
Favorite	9 (20.93)	5 (25.00)	4 (17.39)
Least favorite	7 (16.28)	6 (30.00)	1 (4.35)
Degree to which avatar resembles player it represents			
Not at all	1 (2.33)	0 (0.00)	1 (4.35)
A little	8 (18.60)	3 (15.00)	5 (21.74)
A lot	34 (79.07)	17 (85.00)	17 (73.91)
Time needed to create avatar (30 minutes)			
Too long	17 (39.53)	8 (40.00)	9 (39.13)
Just right	26 (60.47)	12 (60.00)	14 (60.87)
Effort exerted to overcome game obstacles or earn points with self-representational avatar			
Not hard at all	8 (18.60)	4 (20.00)	3 (21.74)
A little harder	20 (44.19)	9 (45.00)	11 (30.43)
A lot harder	16 (37.21)	7 (35.00)	9 (47.83)
Appeal of navigating a self-representational avatar			
Dislike a lot	2 (4.65)	2 (10.00)	0 (0.00)
Dislike a little	1 (2.33)	0 (0.00)	1 (4.35)
Neither like nor dislike	6 (13.95)	2 (10.00)	4 (17.39)
Like a little	10 (23.26)	5 (25.00)	5 (21.74)
Like a lot	24 (55.81)	11 (55.00)	13 (56.52)
Customizable options offered for avatar			
Not enough	6 (13.95)	2 (10.00)	4 (17.39)
Neutral	17 (39.53)	9 (45.00)	8 (34.78)
These are great!	20 (46.51)	9 (45.00)	11 (47.83)
Ratings: game prototype (Flying Carpet)			
Gameplay video clip			
Dislike a lot	2 (4.65)	1 (5.00)	1 (4.35)
Dislike a little	2 (4.65)	1 (5.00)	1 (4.35)
Neither like nor dislike	15 (34.88)	7 (35.00)	8 (34.78)
Like a little	18 (41.86)	7 (35.00)	11 (47.83)
Like a lot	6 (13.95)	4 (20.00)	2 (8.70)
Island setting			
Dislike a lot	4 (9.30)	3 (15.00)	1 (4.35)
Dislike a little	6 (13.95)	3 (15.00)	3 (13.04)
Neither like nor dislike	11 (25.58)	4 (20.00)	7 (30.43)
Like a little	15 (34.88)	7 (35.00)	8 (34.78)
Like a lot	7 (16.28)	3 (15.00)	4 (17.39)
Castle			
Dislike a lot	1 (2.33)	0 (0.00)	1 (4.35)
Dislike a little	6 (13.95)	4 (20.00)	2 (8.70)
Neither like nor dislike	9 (20.93)	6 (30.00)	3 (13.04)
Like a little	14 (32.56)	6 (30.00)	8 (34.78)
Like a lot	13 (30.23)	4 (20.00)	9 (39.13)
Graphics			
Dislike a lot	8 (18.60)	4 (20.00)	4 (17.39)
Dislike a little	6 (13.95)	3 (15.00)	3 (13.04)
Neither like nor dislike	8 (18.60)	4 (20.00)	4 (17.39)
Like a little	13 (30.23)	6 (30.00)	7 (30.43)
Like a lot	8 (18.60)	3 (15.00)	5 (21.74)

(*continued*)

TABLE 3. (CONTINUED)

	Total (n = *43*), n (%)	*Male* (n = *20*), n (%)	*Female* (n = *23*), n (%)
Player actions			
Dislike a lot	1 (2.33)	1 (5.00)	0 (0.00)
Dislike a little	4 (9.30)	2 (10.00)	2 (8.70)
Neither like nor dislike	19 (44.19)	8 (40.00)	11 (47.83)
Like a little	9 (20.93)	3 (15.00)	6 (26.09)
Like a lot	10 (23.26)	6 (30.00)	4 (17.39)
Scenery			
Dislike a lot	3 (6.98)	2 (10.00)	1 (4.35)
Dislike a little	6 (13.95)	3 (15.00)	3 (13.04)
Neither like nor dislike	10 (23.26)	6 (30.00)	4 (17.39)
Like a little	9 (20.93)	4 (20.00)	5 (21.74)
Like a lot	15 (34.88)	5 (25.00)	10 (43.48)
Color theme			
Dislike a lot	0 (0.00)	0 (0.00)	0 (0.00)
Dislike a little	3 (6.98)	1 (5.00)	2 (8.70)
Neither like nor dislike	11 (25.58)	4 (20.00)	7 (30.43)
Like a little	18 (41.86)	11 (55.00)	7 (30.43)
Like a lot	11 (25.58)	4 (20.00)	7 (30.43)
Art style (e.g., black and white, realistic, colorful, cartoon-like)			
Dislike a lot	1 (2.33)	1 (5.00)	0 (0.00)
Dislike a little	5 (11.63)	2 (10.00)	3 (13.04)
Neither like nor dislike	12 (27.91)	4 (20.00)	8 (34.78)
Like a little	12 (27.91)	7 (35.00)	5 (21.74)
Like a lot	13 (30.23)	6 (30.00)	7 (30.43)
Music			
Dislike a lot	10 (23.26)	5 (25.00)	5 (21.74)
Dislike a little	11 (25.58)	4 (20.00)	7 (30.43)
Neither like nor dislike	8 (18.60)	5 (25.00)	3 (13.04)
Like a little	10 (23.26)	4 (20.00)	6 (26.09)
Like a lot	4 (9.30)	2 (10.00)	2 (8.70)

whereas women (47.8%) were more likely than men (35.0%) to report that they would work ''a lot'' harder. When examining gender differences in overall teen reactions to the prototype, few differences were observed. Those of note, however, were that more women than men liked the gameplay prototype ''a little'' (47.8% women; 35.0% men) and the scenery ''a lot'' (43.5% women; 25.0% men). They were also more likely to report disliking the music ''a little'' (30.4% women; 20.0% men), whereas men were more likely than women to report liking the color theme ''a little'' (55.0% men; 30.4% women).

Qualitative findings indicated that teens liked *Tropical Mystery* because of its mystery and uniqueness, as well as the action and fun suggested in the story overview. *Island Warrior* was rated as the least favorite, because teens did not like the princess and dragon theme and the minimal challenges presented (i.e., finding treasures to tempt the dragon). In comparison to the other storylines, it was deemed dull and not as exciting. They also thought it was not original—that is, it was too similar to the storyline in another game.

Teens also thought that the avatar looked realistic, although some suggested sharpening the features to make them more closely resemble the player. They had positive reactions to playing an Exergame with an avatar that looked like them and said that it would make them feel as though they were in the game. Although most thought 30 minutes was appropriate for creating a self-representational avatar, others thought it was too long, because they preferred to ''jump into action'' and to start playing right away. Waiting was frustrating, because it took time away from gameplay. Most felt that the customization options were good and helped make the avatar fit their personality even more. Many suggested adding different customization options such as clothing, accessories (jewelry, hats), and having the ability to tweak height and weight. When asked about the *Flying Carpet* videogame, they reported that the setting was too young and childish. Suggestions included using better graphics, a more realistic setting, and more action.

Application of round 2 results

Using the findings from the formative data collection as a guide, an additional prototype was developed and finalized for the feasibility study. The prototype was titled *Nightmare Runner* (Fig. 4). [Please refer to Supplementary Data online at www.liebertonline.com/g4h.]

Nightmare Runner was developed by using the game engine Unity. Unity utilizes Microsoft Windows as a platform and Microsoft's Kinect v2 as the user input system. The following preliminary specifications guided game development:

(1) The game requires the player to engage in PA.
(2) The intensity of the PA should be variable and adjustable.
(3) The game should have a variable duration of gameplay.
(4) The game should have a story/mission.

FIG. 4. A snapshot from the *Nightmare Runner* game prototype, where the player has been taking a rest by standing still for 9 seconds (see ''rest time'' meter). Standing still results in the player's avatar limping and losing dream energy (see ''dream meter'') at a fast rate.

Storyline. *Nightmare Runner* begins with the player's avatar falling asleep. While sleeping, the player becomes trapped in a dream world. When exploring this world, the player comes across a dark cave and awakens a monster that inhabits their nightmares. This begins the actual game, where the player navigates their avatar in an attempt to outrun their nightmare and dodge dream-world obstacles. While running, the player continuously loses energy, known as ''dream energy,'' which represents their stamina in the game. When faced with an obstacle that they do not overcome, even more dream energy is lost. However, players can replenish dream energy by collecting ''dream shards'' that appear in the game.

If the player reached the end of the game at the end of game-play and was not caught by the nightmare, an ending cut scene was shown. In the cut scene, the player runs into a large gap in the dream world, a gap seemingly too large to jump. Faced with their nightmare and a leap of faith, the player must gather up their energy and jump. The player ends up safely on the other side and realizes that since it is their dream, they have some control over it. They use their remaining dream energy to fire a magic bolt at the nightmare, killing it. The player then escapes from the dream world.

Controls. The controls for the prototype utilized Microsoft Kinect v2. The player controlled the avatar by personally performing the required action in the ''real world.'' For example, if they wanted their avatar to jump, the player needed to jump, and if they wanted their avatar to squat, the player had to squat. To make the avatar run, the player had to run in place. If the player stands still or moves slowly, the avatar will begin limping and lose energy at a fast rate. As soon as the player performed the needed action in the real world (e.g., starts running again), their avatars stopped limping and the loss of dream energy was reduced. The player begins the game with 100 dream energy points. If their dream energy points reached 0 (i.e., de-plenished), the nightmare catches up to them, and the game ends.

To prevent over-exertion and to allow the player to match intensity to the perceived fitness level (thus emphasizing autonomy and competence), three 20 minute intensity levels were developed, ranging from easy to difficult. All three intensity levels were shown at the beginning of the game and the player selected the one they wanted. The game began with a pre-created high-quality animation clip that presented the story background. During gameplay, an algorithm calculated the accumulated calories that had been burned and displayed them on the game screen (''calories burnt,'' top left corner), as well as other information, such as current game score (''score,'' top left corner above calories burnt), the number of ''game coins'' (yellow disk, in the brown box at the top left corner) that are used to compute the game score, collected by the player via body and hand movements, the number of ''dream shards'' collected by the player (avatar figure, in the brown box with game coins at the top left corner; dream shards can be converted into dream energy), ''dream energy'' (also called dream meter; player begins game with 100 dream energy points), the remaining time in the game (bottom center of the screen), and the amount of time the player has been resting or inactive (''rest time,'' bottom right corner; when the player resumes activity, this

converts to ''0''). If the player is inactive, a motivational message encouraging the player to continue appears (middle of the screen), for example, ''Your energy is losing quickly, please move fast!''

Discussion

Exergames are a potentially important way to encourage and motivate teens to be more physically active.[32] Unfortunately, results regarding their effectiveness at achieving this goal are mixed.[16,18] The purpose of the research reported here was to demonstrate a systematic method for including teens in the development of an Exergame navigated by a self-representational (i.e., photorealistic) avatar and to investigate teen reactions to this type of avatar. To our knowledge, this is the first study to investigate this. This research may provide important insights into how to design Exergames that encourage teens to play more often, longer, and with higher intensity, thus leading to increased PA. It also adds support to the importance of conducting formative research when developing an Exergame for teens.[27,32] Future research will assess the feasibility of this approach (i.e., early-stage research to ensure the program is ready for efficacy testing)[33] and its preliminary effect on PA.

In many ways, this research confirmed the work of others. Teens play videogames in a variety of different ways, from game consoles to cellphones, and they play videogames from different genres and rating levels.[10]

Teens reported that it was very important to play a videogame with an avatar that was under their control, and they had favorable reactions to navigating a self-representational avatar through the game. They also reported wanting to customize the avatar. This is consistent with SDT,[25] which contends that fulfilment of the basic psychological needs (autonomy, competence, relatedness) is an important aspect of autonomous (self-directed) motivation to engage in a specific behavior. Having control (autonomy) over a self-representational avatar (relatedness), customizing its look (autonomy), and navigating it through differing challenges and obstacles (competence) are consistent with SDT.

Having positive reactions to navigating a self-representational avatar through an Exergame is not surprising, given that players often identify with their avatar,[23] particularly when the avatar is perceived as similar in some way. For example, an avatar consisting of a 3D head model created from photographs of the player that was then super-imposed on a generic human body led to higher levels of PA when there were direct effects on the avatar (e.g., weight gain or loss).[24] This is also consistent with research showing that players who played a Wii Fit™ Exergame with a Mii (i.e., avatar) representing their ''ideal self'' (i.e., an Mii that reflected their desired body) perceived the game as more interactive than those who played the Exergame with an avatar that represented their ''actual self'' (i.e., reflected their actual body).[34] However, neither avatar resembled the player as closely as the avatar in the current study (i.e., both facial features and body). Research is needed to examine the effect of a photo-realistic avatar on PA intensity and duration.

Story was also found to be important to teens. This is not surprising, given that story is a ubiquitous form of communication that has been used to transmit key information to others for generations.[35] Other research has demonstrated the importance of story and characters in Exergames promoting PA to children (8–11 year olds).[36] Future research should further investigate the types of stories and story elements that are the most relevant for motivating children and teens to be more physically active when playing an Exergame, particularly when played with a self-representational avatar.[32]

Similar to the findings of other studies, gender differences and similarities emerged.[10,31,37–39] A novel finding was that women liked to play games competitively. This is inconsistent with research by Hartmann and Klimmt (2006),[38] who found that women did not like competition as much as men. Future research is needed to more fully explore this dimension of videogames, particularly in the context of Exergames navigated by a self-representational avatar.

Strengths of this study include stratification of participants on key factors that influence PA, use of mixed methods to collect data, multiple rounds of data collection, and the integration of behavioral and computer science experts to develop an Exergame for teens. Weaknesses include a small sample size, conducting research in a limited geographical area that may influence generalizability, and not collecting information on other factors that may influence PA, such as self-efficacy or outcome expectations.

Future research will examine whether the use of a self-representational avatar in an Exergame with teens is feasible (i.e., that it is ready for efficacy testing).[33] Once feasibility is established, the next logical step would be an outcome evaluation with a large, fully powered sample to examine the efficacy of this approach at increasing teen PA and at conducting mediation and moderation analyses to identify mechanisms of effect and groups with whom this approach is the most likely to be effective at enhancing PA.

Conclusion

This research contributes to the body of knowledge regarding whether an Exergame navigated by a self-representational avatar appeals to teens. This is one of the first studies to provide evidence that teens, regardless of gender, have favorable reactions to navigating an Exergame with a self-representational avatar; ultimately, this approach may offer insight into how to design Exergames that motivate teens to play Exergames with a higher frequency and intensity.

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Author Roles

Dr. Thompson was co-principal investigator for this project. She led the qualitative research. Ms. Cantu was the senior research coordinator for this project and coordinated all aspects. Mr. Rajendran was one of the research assistants for designing and programming the last game prototype ''Nightmare Runner.'' Mr. Rajendran was one of the research assistants for designing and programming the last game prototype ''Nightmare Runner.'' Mr. Bhargava was one of the research assistants for designing and programming the avatar creation system. Ms. Zhang was one of the research assistants for designing and programming the avatar creation system. Ms. Chen was the research assistant for designing and programming the first and second game protoypes. Ms. Liu was the biostatistician for the project and analyzed the quantitative data. Dr. Deng was co-principal investigator for this project. He led the overall design of the project.

Author Disclosure Statement

No competing financial interests exist.

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