JMIR Serious Games

Journal Impact Factor (JIF) (2023): 3.8
Volume 2 (2014), Issue 1   ISSN 2291-9279   Editor-in-Chief: Gunther Eysenbach, MD, MPH

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Viewpoint

Evaluating the Benefits of Collaboration in Simulation Games: The Case of Health Care

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Abstract

Background: Organizations have used simulation games for health promotion and communication. To evaluate how simulation games can foster collaboration among stakeholders, this paper develops two social network measures.

Objective: The paper aims to initiate two specific measures that facilitate organizations and researchers to evaluate the effectiveness of Web-based simulation games in fostering collaboration.

Methods: The two measures are: (1) network density and (2) network diversity. They measure the level of connectedness and communication evenness within social networks. To illustrate how these measures may be used, a hypothetical game about health policy is outlined.

Results: Web-based games can serve as an effective platform to engage stakeholders because interaction among them is quite convenient. Yet, systematic evaluation and planning are necessary to realize the benefits of these games. The paper suggests directions for testing how the social network dimension of Web-based games can augment individual-level benefits that stakeholders can obtain from playing simulation games.

Conclusions: While this paper focuses on measuring the structural properties of social networks in Web-based games, further research should focus more attention on the appropriateness of game contents. In addition, empirical research should cover different geographical areas, such as East Asian countries where video games are very popular.

(JMIR Serious Games 2014;2(1):e1) doi:10.2196/games.3178

KEYWORDS

simulation games; health policy; social networks

Introduction

Study Design

Research has shown that games have great utility for health promotion and communication. Children with chronic health conditions can learn how to manage their diet and maintain healthy lifestyles with the aid of video games [1]; whereas elderly patients can increase reaction times and improve other cognitive tasks upon playing an appropriate amount of video games [2]. More recent research has also shown that physicians benefit from virtual games in receiving professional training [3].

Health organizations have started to use games for various pedagogical and communication purposes [1,3]. Two features of Web-based simulation games are important. First, these games enable players to experience collaboration. This experience is useful for players to better understand the benefits and difficulties in collaboration. Second, playing online is convenient. It allows players to connect without traveling, and game logistics can be handled by the computer.

Yet, these benefits need to be better evaluated to facilitate health organizations in applying games more systematically. In particular, while the individual-level benefits of games have received more attention in literature, it is unclear how simulation games foster collaboration. This paper develops two measures from the social network literature, network density (DEN) [4] and network diversity (DIV) [5], which can be used to evaluate the structure of collaboration in Web-based simulation games.

I first discuss selected findings in the relevant literature. This section provides a general orientation for the rest of this paper and also identifies research gaps that motivate my analysis. Next, I use a specific US health policy, the Patient Protection and Affordable Care Act (PPACA or ACA for short), to outline the roles of a possible Web-based simulation game. This outline will help illustrate how social networks in games can augment the individual benefits, and how the two proposed measures can be used empirically. In the final section, I summarize the paper's major contributions and provide directions for further research.

Relevant Studies

As mentioned, simulation games enable players to better understand specific issues with simulated experience [3,6-8]. Games that are endorsed and managed by a credible organization, such as an educational institute, a government agency, or an academic medical center, can be particularly effective in recruiting players and sustained participation. For example, the game "President for a Day", developed by the Public Broadcast Service, seeks to engage school-aged children, and help them better understand the everyday life of US presidents. Assuming the role of a US president in the game, the player is given some freedom about possible actions, including attendance of different meetings in the White House, going to public hall hearings, delivering a speech, and so on [9].

In terms of knowledge-based benefits, simulated experience is able to improve rote memorization and traditional classroom learning. In one study, nurse training was shown to improve by up to 18% with simulation games [10]; in another study, surgeons could work 27% faster in laparoscopic surgery with simulation training [11]. In terms of affection-based benefits, research has shown that students of different ages have become more enthusiastic in national policies due to the simulated experience of a video game [12].

To evaluate individual-level benefits, whether knowledge- or affected-based, a health organization may examine whether the simulation game has increased the knowledge and affection of a targeted audience (eg, students or patients of certain groups) with a pre/post-test design or other quasi-experimental techniques [13]. Yet, these techniques are less effective in studying the collaboration among players. For health organizations to consider using games, it is useful to assess how players communicate and collaborate while playing the game, and whether these collaborations actually produce achievement.

Some researchers have already adopted indicators to measure the dissemination effectiveness of Internet contents. Open-source and commercial software is available to handle certain analytic tasks automatically. For example, an organization may build a Facebook company page to engage its stakeholders. The level of engagement may be captured by software [14] and measured by such indicators as the number of subscribers, the amount of discussions, and the frequency of share. The researcher or practitioner may also identify predictors, including organizational profile, geographical location, and contents of wall posts to assess their impact on various engagement indicators [15].

Yet, these indicators have shortcomings. Most importantly, since the number of users in specific Internet platforms varies, a sheer count on the number of feedback is insufficient. For example, in a social media platform with relatively few subscribers, a post that could generate feedback from subscribers of diverse backgrounds or geographical locations, even if the sheer number is not big, might be regarded as quite effective. In contrast, for a social media platform with a large number of subscribers, there could be many counts of feedback from only a small proportion of the total subscribers [15]. A better measure is closer to a ratio, which takes into account the number participation of users relative to a base. Also, older measures paid little attention to the interactions among users. When a game platform is implemented, it is useful to find out whether only a small or large cluster of users have interacted in the platform. In this conceptual paper, I seek to demonstrate how network measures can be used for these purposes.

Methods

A Possible Health Policy Simulation Game

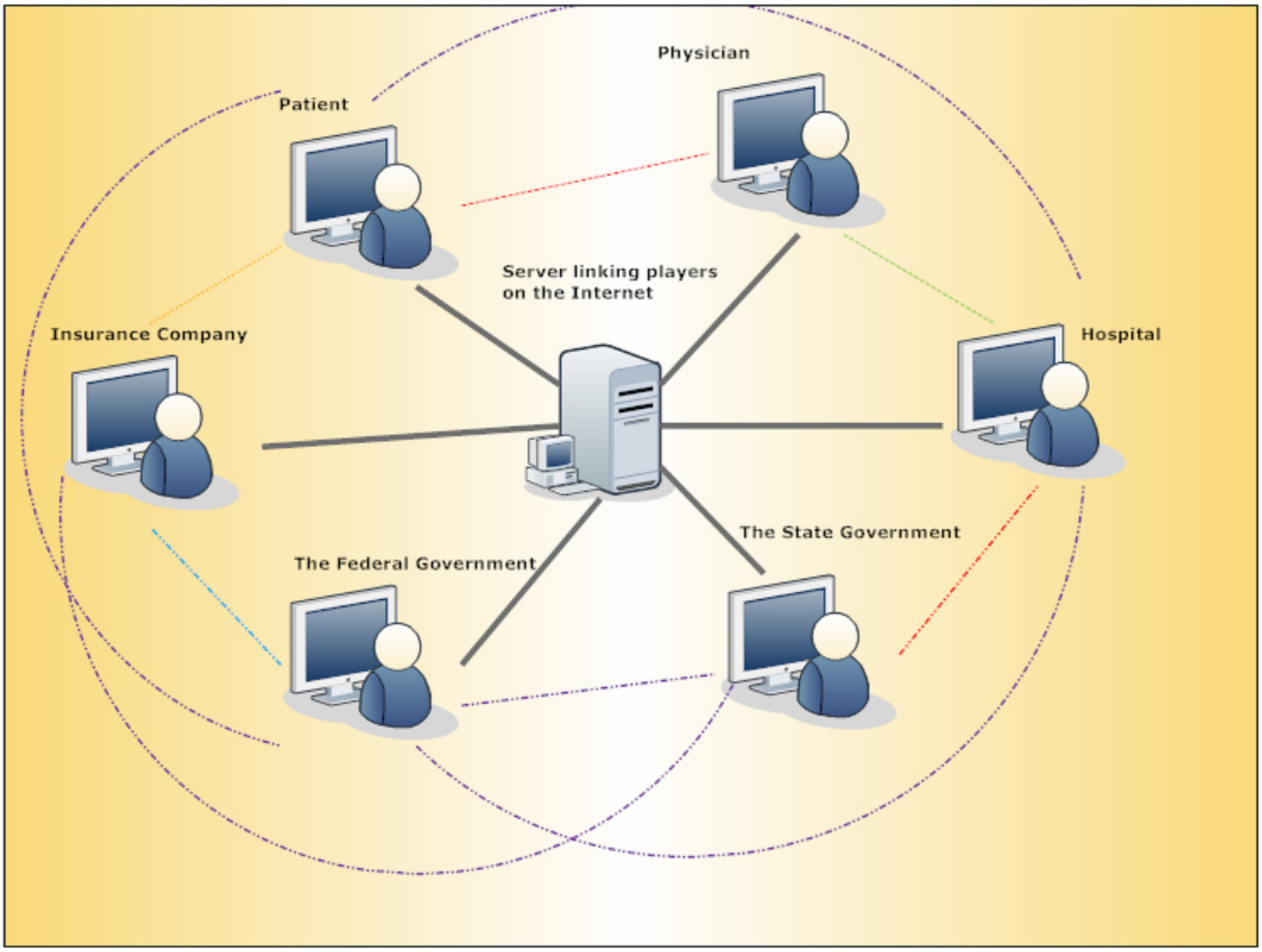
Overview

Before discussing social network measures, it is useful to propose an actual game. Suppose a public health professor seeks to help students understand the ACA in the United States. While the ACA is relevant to a large group of stakeholders, in the game, players would also take a role. The role is supposed to represent a specific group of stakeholders, how these stakeholders may react to the ACA, and even how they negotiate and collaborate [16].

For simplicity, I describe six possible roles: "the federal government", "the state government", "the hospital", "the insurance company", "the physician", and "the patient". These are the roles, but not necessarily the number of players. That is, each role may include multiple players. The game may be divided into different scenarios, or tasks, such as building the health insurance market place or expanding public health coverage in the ACA (Figure 1).

In the game, the player's game performance would be assessed by different indicators. Briefly, players are motivated to play the chosen role successfully, like any other simulation game. Players would be required, and reminded regularly, to initiate communication and exchange information with other players (represented by the dotted lines in Figure 1). The game would require players to interact with other players and come up with joint actions. These interaction activities are of the main interest here, so they would be recorded by the backend computer, and analyzed by the researcher.

Figure 1. A Web-based simulation game of health policy.



The Federal Government

In this role, the player may be given a hypothetical title of "ACA Secretary", who is responsible for promoting the ACA to the general public, regulating and implementing the policy at the federal and state levels, and working with the academic and private sectors. In the simulated world, the player will take initiative to organize different activities, including meetings with researchers and business representatives, distributing research funding to study ACA policy implications, and so forth.

In the background, the game will generate random, but reasonable, environmental conditions that affect different stakeholders. How the game proceeds depends on these environmental conditions and actions are taken by different players. For example, once meetings with state-level government officials are done, the game can tell the federal government player how many attendees had a positive or negative reaction toward the new policy, how many states had decided to accept a specific federal government's initiative, such as expanding the Medicaid, how many new research projects are completed with new funding, etc. Based on all these tasks, the game may compute a score about the player's performance.

The State Government

In this role, the player may be given a hypothetical title of "State ACA Representative". The player can choose his/her desired state with a certain orientation toward supporting or opposing the ACA due to politics, citizens' local culture, and other state-specific characteristics. Like the federal counterpart, this role is also responsible for engaging the general public, and working with the academic and private sectors. But unlike the federal counterpart, this role is required to negotiate with the federal ACA secretary at various times, such as the autonomy the state can hold with regard to how state government agencies can use the new Medicaid funding.

Similar to the federal government role, the game will generate certain environmental conditions randomly in the background. For example, the game can tell the player how many attendees after a town hall meeting had a positive or negative reaction toward the ACA, how many still had confusion about the policy, and whether the state's government officials have generally decided to support or oppose certain parts of the ACA. Again, based on various tasks, the player may be scored by the game at various times.

The Hospital

In this role, the player may be given the title of "Chief Executive Officer" (CEO). Like the state representative, the player can choose his/her desired locality with a certain business environment, political orientation, culture, and so on. Unlike the government roles, the hospital chief is more concerned with the policy's outcomes, such as the organization's relationship with patients and its business operation, than the policy's implementation per se.

There will be different tasks to perform for this role as well. For example, as the ACA unfolds, the hospital officer will monitor how business revenues have or have not changed over time. The officer will also meet with other staff in the hospital periodically, including the Chief of Staff, the Chief Financial Officer, the Medical Director, and others to gauge their reaction toward the new policy. The CEO will also suggest new marketing policies, such as the use of social media.

In the background, the game will generate random environmental conditions, such as whether the hospital's market share has been affected after the new law, or whether physicians have increased job satisfaction, among others. Based on various tasks, the player may be scored by the game at various times.

The Insurance Company

In this role, the player may be given the title of "Regional Director" of a hypothetical insurance corporation. Again, the player can choose his/her desired locality with a certain orientation toward supporting or opposing the ACA due to politics, culture, and so forth. The Regional Director is primarily interested in business performance by keeping a large enrollee base of the firm's insurance packages.

The director's everyday tasks, include negotiating with providers such as hospitals and physicians for discounted services, monitoring business performance, meeting with government officials to understand new policy initiatives, etc. The director may also develop new Health Maintenance Organization or Preferred Provider Organization packages to attract new enrollees.

In the background, the game will generate random, but reasonable, outcomes that affect the insurance company. For example, the game can tell the player whether the insurance company has received new analytical reports about a changing risk pool in the local population, whether the new law has affected profitability due to new mandatory requirements, whether providers are or are not willing to provide the desired discounts, among others. Based on various tasks, the player may be scored by the game at various times.

The Physician

In this role, the player can choose to become a solo-practice physician or one that is employed by a large hospital system. He/she can also choose to become a general practice or 1 of 24 specialties defined by the American Medical Association. Like the state representative, the player can choose his/her desired locality with a certain orientation toward supporting or opposing the ACA due to politics, culture, and so on. The physician will face different tasks and may encounter various job-related challenges. For example, he/she will need to meet with other staff in the health system periodically to discuss new reimbursement policies, penalties to hospitals for readmissions, patients' engagement strategies, and others.

In the background, the game will generate random, but reasonable, outcomes that affect the physician's work satisfaction, income level, relationships with colleagues and patients, and more. For example, the game can tell the player how the physician's decision to adopt electronic medical records has increased the clinic's efficiency and patients' satisfaction. Based on the performance of various tasks, the player's income will vary. The game can also assign an overall score to the player at various times.

The Patient

Finally, the player can assume the role of a patient in this game. Like other roles, the player can choose his/her desired locality with a certain orientation toward supporting or opposing the ACA due to politics or culture, among others. Since this role covers more variability in the actual population, the player may be given more choices in building the role. For example, the player can choose his income level, family status, health status, etc. For players who do not have a preference, the game may generate a given role status with specific profile variables. The player will manage the role based on these variables.

Subsequently, the patient would be interested in how the ACA can help them for various health-related tasks. These include whether they are eligible for Medicaid coverage under the new law, what types of insurance packages are available in the new Health Insurance Marketplace, what penalties they would face if they do not purchase insurance coverage, among others.

In the background, the game will generate random, but reasonable, outcomes that affect the patient in different ways. For example, the game can tell the player whether his or her health status has improved after the ACA, whether the family has obtained useful benefits, whether costs have been increased or decreased, and so on. Based on various tasks, the player may be scored by the game at various times.

Evaluating the Game's Utility

To evaluate collaboration, it is useful to think of players as representing stakeholders in the health sector. Stakeholders are members within a network, and stakeholders may be defined as individuals or groups who can affect or are affected by the achievement of certain organized objectives [17]. Early development of the stakeholder theory emphasized dyadic relationships between the organization and its stakeholders. This emphasis has been criticized as not paying sufficient attention to the interactions among stakeholders themselves [17].

In the context of simulation games, a focal organization (eg, a government agency or a college) may invite its members to play the game. The game essentially provides a network environment that enables its stakeholders to interact and build ties among themselves. These interactions can disseminate and produce useful knowledge.

Network Density

Whether the interactions are successful or not depends on how connected the game network is. The connectivity of a game network can be measured by a concept called "network density". DEN indicates how fully the potential of connectivity is actually realized. For example, in Figure 2a, "Focal", "b", "c", "d" are the players. With 4 players, the number of possible communication ties in the matrix of Figure 2a is 12 (ie, all the nondiagonal cells). If the number of actual ties is 6 (the cells with a “1”, indicating the presence of a communication exchange), DEN may be computed as 6/12 = 0.5.

It is noteworthy that one may distinguish between directional and nondirectional ties (ie, it does not matter whether an actor is a “sender” or “receiver” of the communication tie). For nondirectional ties (without “self-to-self” ties),

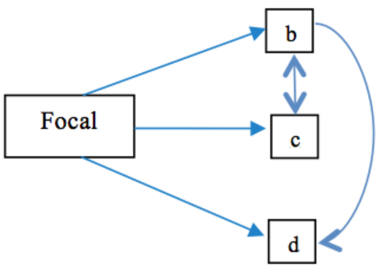
Possible Ties (PT) = (N) × (N-1)/2 (1)

where N=number of actors in the network. For example, when N=4, PT = 6 (the number of upper nondiagonal cells in a 4 × 4 matrix; Figure 2a). For directional ties (without self-to-self ties),

PT = (N) × (N-1) (2)

when N=4, PT = 12 (the number of all nondiagonal cells in a 4×4 matrix). If a researcher was only interested in whether a communication tie between 2 actors existed at all, then the use of a nondirectional tie is sufficient.

Figure 2. (a) Graph and matrix representations of stakeholder relationships, and (b) formal network density equation.



	Focal	b	c	d
Focal	-	1	1	1
b	0	-	1	1
c	0	1	-	0
d	0	0	0	-

(a)

Formally,

$$Network\ Density\ (Den) = \frac{Actual\ Ties\ (AT)}{Possible\ Ties\ (PT)}$$

(b)

The Whole is Greater than the Sum of Its Parts

Following Figure 2a, Web-based simulation games can generate more activities than the focal organization (eg, a school or a hospital) can directly involve. The engagement and the communication disseminates through peer-to-peer interactions. It is clear that the number of interactions increases exponentially relative to the increase in the number of stakeholders (Table 1 and Figure 3).

Using 10, 50, and 100 stakeholders (including the focal organization) as N for computation, in Figure 2, one can demonstrate the exponential increase, relative to the number of possible interaction ties that must involve the focal organization.

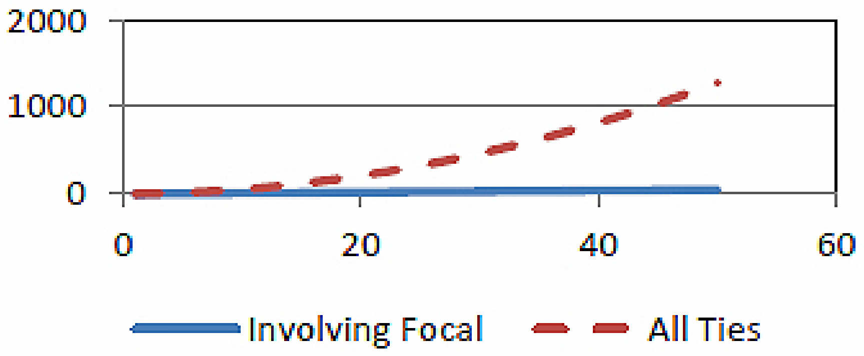
Thus, in a network of N=10, the number of possible ties that must include the focal organization is 10; whereas the number of all possible ties in the same network (N=10) is 45. In a network of N=100, the corresponding figures are 100 vs 4950.

In other words, as the game enrolls more players, the influence increases exponentially. This provides a strong justification for enrolling a large number of players. These peer-to-peer exchanges may need meaningful collaborative activities (eg, development of new knowledge and social support groups). In this limited sense, building a social media platform (to enable interactions in the whole network) has a much greater value than summing up the dyadic ties between a focal organization and its stakeholders.

Table 1. Comparison between the numbers of ties involving and not involving the focal organization.

Number of stakeholders	Number of ties involving focal organization	Number of all ties
1	1	1
2	2	3
10	10	45
50	50	1225
100	100	4950

Figure 3. Comparison between the number of ties involving and not involving the focal organization.



Network Diversity

While DEN focuses on the existence (or nonexistence) of ties between actors in a network, connected actors may engage in repeated interactions (eg, back-and-forth communication exchanges). For example, in a game with 10 players (or N=10), 2 active players alone might have 10 repeated interactions. These were also the total number of interactions in the whole network. There were no exchanges in the rest of the game network (ie, everyone else remained silent). In another network of 10 stakeholders, there were also 10 interactions. But these interactions involved everyone in the network. Intuitively, the latter network was more "even".

DIV quantifies this intuition of "evenness". Assume again the focal organization has enrolled 9 players to its simulation game platform, creating a network of N=10. The interactions can be represented by a 10×10 matrix. Further assume that the researcher is only interested in nondirectional and non–self-to-self ties. This means that only the upper nondiagonal cells in the matrix need to be counted. Following Figure 2(b) the number of possible ties is (10) × (10-1)/2 = 45.

Yet, the game network allows repeated interactions between any pair of players. Thus, the value in each cell of the matrix could have a value other than 1 and 0. For example, between actors 1 and 2, there could be two, three, four, or any positive number of communication exchanges. DIV considers whether all interactions within a network are concentrated among a relatively small group of actors or the interactions are evenly distributed among all actors.

In the context of simulation games, the questions are: Do interaction exchanges concentrate among a small group of active players? Or do interaction exchanges take place between all enrolled players?

To define DIV, I borrow the concepts of topological diversity and Shannon entropy from ecological research. The major formulae from the concepts enable me to measure the number of activities within a network in conjunction with the network's size. Figure 4 describes how DIV is derived.

To interpret this measure (DIV), assume that an online game was initiated by a hospital to introduce a new health policy. A high DIV score suggests that communication exchanges are evenly distributed among all enrolled players, so the dissemination value of the game may be regarded as relatively high; a low score suggests that communication exchanges are concentrated among a small group of players, so the dissemination value may be considered relatively low.

It is also useful to reveal whether certain roles of players tend to collaborate more often in specific policy scenarios. For example, when building the health insurance market place, do the roles of insurance companies and the state government collaborate more frequently?

Both measures capture collaborations at a specific time (ie, cross-sectional). Researchers need repeated application of these measures to capture changes and stability over time (ie, longitudinal).

Figure 4. (a) Represents the Shannon's diversity index equation. (b) Represents the communication exchange between the players. (c) Shows network diversity as it relates to Shannon's entropy and player's wall postings.

$$H(i) = -\sum_{j=1}^{k} p_{ij} \log(p_{ij}) \quad \text{(a)}$$

$$p_{ij} = \frac{V_{ij}}{\sum_{j=1}^{k} V_{ij}} \quad \text{(b)}$$

$$Network\ Diversity\ (Div) = \frac{-\sum_{j=1}^{k} p_{ij} \log(p_{ij})}{\log(k)} \quad \text{(c)}$$

k = number of players to the game
i, j = all players (including the focal organization) in the game
p_{ij} = the proportion of player i's communication exchange that involve j
V_{ij} = the communication exchanges involving i and j
Network Diversity = Shannon entropy (H) associated with individual i's wall-post exchanges, normalized by k

Results

Suppose a hypothetical game on the ACA is built (Figure 3), how can researchers use the 2 network measures to evaluate its utility? I recommend the following steps in Textbox 1.

With data collected in step 4 of Textbox 1, the researcher is able to evaluate the collaboration utility of the game based on the 2 measures discussed above. For example, the researcher may examine how DEN increases or decreases after the game started. With sufficient data, the researcher can even come up with estimates regarding how soon online interactions would die down. This would enable the organizer to adjust the game's time span in step 6 shown in Textbox 1.

Similarly, the researcher may use DIV to analyze where the interactions are most frequent. For example, do interactions tend to come from players who assume certain roles (eg, physicians and patients)? Would interactions generate different clusters, such as clusters of physicians and patients and clusters of federal and state governments?

Finally, if the researcher is able to solicit additional participation from players, it is possible to examine whether or not, and how, social networks augment the individual benefits that players obtain from the game. Table 2 includes several research questions that are made possible with the 2 social network measures.

Textbox 1. Steps to evaluate the utility of network measures.

1. Specify the pedagogical goals of the simulation games,
2. Develop scenarios to segment the game in line with the pedagogical goals,
3. Put the games on Web-based platforms (preferably with attractive graphics) that can generate random and reasonable environmental conditions,
4. The background computer should be able to record interactions among players and perform social network analysis as specified in the previous section,
5. Nominate a credible organizer (eg, an educational institute) who would take the responsibility of initiating the game (even though the analysis of the above measures is handled by the computer),
6. Recruit players to participate in the game. Preferably the number of players for each role is even in the game,
7. Determine an official start and end times for the game (or for each scenario),
8. Appoint a researcher to evaluate the utility of the game,
9. Organize one or more postgame session(s) to debrief participants with research findings from the researcher, and
10. Consider modifying the game and/or restarting the game with another group.

Table 2. Knowledge- and affection-based benefits of online games augmented by network density and diversity.

	Knowledge-based	Affection-based
DEN	Whether many players have acquired knowledge about health policy within networks?	Whether many players have shown increased support to a health policy within networks?
DIV	Whether players interact evenly within health networks regarding health policy?	Whether players influence one another evenly within networks regarding health policy?

Discussion

In the health sector, networks continue to be important in linking organizations and individuals together. Web-based simulation games offer an opportunity to build social networks linking different stakeholders. As I attempt to show in this paper, the focal organization might still play the "broker" role to organize a game to increase legitimacy of playing. Yet, it is the actual interactions among individual players that matter. As my analysis shows, the greater the number of players, the greater the potential for stakeholder engagement, relative to the direct influence exerted by the focal organization.

On the other hand, the above measures only evaluate the effectiveness of social networking in games structurally. The contents covered in the game, such as what and how to play the game, need to be studied in other innovative ways. The content in the online interactions among players is important as well. One fruitful research direction is to collect and analyze empirical data from actual online game networks. Researchers can then reconsider whether the interpretations above make practical sense.

Given the availability of existing computer programs, software and application programming interface, analyzing empirical data with the network measures discussed is quite viable at the implementation level. One possible approach is to expand existing mobile apps and/or games developed by commercial vendors with algorithms that compute the social network measures discussed in this paper. This approach will speed up the process of developing a real product to be used in the health sector. Further research should also consider the impact of games in different geographical areas. For example, researchers have found that video games are extremely popular in East Asian countries, such as South Korea and China [18]. Will the social networks potential of games be high in these countries? What are the constraints and opportunities to use online games for health promotion purposes in these countries? I believe future research publications and professional conferences should address these meaningful questions.

Conflicts of Interest

None declared.

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Abbreviations

CEO: chief executive officer
DEN: network density
DIV: network diversity
PPACA or ACA: Patient Protection and Affordable Care Act
PT: possible ties

Edited by G Eysenbach; submitted 11.12.13; peer-reviewed by J Li; comments to author 05.01.14; revised version received 07.01.14; accepted 07.01.14; published 28.01.14.

Please cite as:
Leung R
Evaluating the Benefits of Collaboration in Simulation Games: The Case of Health Care
JMIR Serious Games 2014;2(1):e1
URL: http://games.jmir.org/2014/1/e1/
doi:10.2196/games.3178
PMID:25658851

Original Paper

DietBet: A Web-Based Program that Uses Social Gaming and Financial Incentives to Promote Weight Loss

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Abstract

Background: Web-based commercial weight loss programs are increasing in popularity. Despite their significant public health potential, there is limited research on the effectiveness of such programs.

Objective: The objective of our study was to examine weight losses produced by DietBet and explore whether baseline and engagement variables predict weight outcomes.

Methods: DietBet is a social gaming website that uses financial incentives and social influence to promote weight loss. Players bet money and join a game. All players have 4 weeks to lose 4% of their initial body weight. At enrollment, players can choose to share their participation on Facebook. During the game, players interact with one another and report their weight loss on the DietBet platform. At week 4, all players within each game who lose at least 4% of initial body weight are declared winners and split the pool of money bet at the start of the game. Official weigh-in procedures are used to verify weights at the start of the game and at the end.

Results: From December 2012 to July 2013, 39,387 players (84.04% female, 33,101/39,387; mean weight 87.8kg, SD 22.6kg) competed in 1934 games. The average amount bet was US $27 (SD US $22). A total of 65.63% (25,849/39,387) provided a verified weight at the end of the 4-week competition. The average intention-to-treat weight loss was 2.6% (SD 2.3%). Winners (n=17,171) won an average of US $59 (SD US $35) and lost 4.9% (SD 1.0%) of initial body weight, with 30.68% (5268/17,171) losing 5% or more of their initial weight. Betting more money at game entry, sharing on Facebook, completing more weigh-ins, and having more social interactions during the game predicted greater weight loss and greater likelihood of winning (*P*s<.001). In addition, weight loss clustered within games (*P*<.001), suggesting that players influenced each others' weight outcomes.

Conclusions: DietBet, a social gaming website, reached nearly 40,000 individuals in just 7 months and produced excellent 4-week weight loss results. Given its reach and potential public health impact, future research may consider examining whether a longer program promotes additional weight loss.

(JMIR Serious Games 2014;2(1):e2) doi:10.2196/games.2987

KEYWORDS

commercial weight loss; Web-based intervention; social gaming; financial incentives

Introduction

Obesity Prevalence and Treatment Availability

Over 45% of the world population and approximately 66% of American adults are overweight or obese [1,2]. Excess adiposity is associated with serious health risks, including diabetes, cardiovascular disease, and some types of cancer [2,3]. Behavioral weight loss programs consistently yield weight loss of 8 to 10kg, which are associated with significant health improvements, including reduced risk for diabetes [4]. However, behavioral programs are largely university-based and are, therefore, only available to a small portion of overweight and obese individuals in need.

Accessibility of Internet Commercial Weight Loss Programs

In contrast, commercially available weight loss programs have wide reach, particularly Web-based interventions. In fact, a large percentage of individuals who attempt weight loss report using commercial programs [5], and, in recent years, enrollment in Web-based interventions has increased substantially [6]. The appeal of Internet interventions is likely due to the reduced participant burden associated with frequent in-person visits (eg, time, transportation). Another important benefit of Web-based interventions is their inherent reach; given that Internet access has increased exponentially over the past decade [7], Web-based programs are widely accessible to individuals who may not otherwise have access to clinical weight management interventions. Similarly, such programs are accessible 24-hours a day in a variety of locations (home, work, public libraries). Given their appeal and ability to reach large numbers of overweight and obese individuals in need, commercially available Web-based interventions have significant public health potential.

Evidence for Commercial Weight Loss Programs

Despite their potential to improve public health, the scientific literature on the effectiveness of Web-based commercial weight loss programs is sparse [5]. Only two programs have been rigorously evaluated in randomized trials: eDiets [8,9] and The Biggest Loser Club [10]. Results of the eDiets trials showed that participants assigned to eDiets achieved significantly less weight loss than those assigned to a self-help condition or an Internet behavioral weight loss program [8,11]. Similarly, while the Biggest Loser Club produced greater weight loss than a no treatment control condition, given that the program was 3 months in length, the weight loss was modest (-2.1kg) [9]. These randomized trials have clear benefits and are essential to demonstrate efficacy. However, an important shortcoming is that, given the nature of rigorous, randomized trials (screenings, run-ins, retention efforts, etc), the results may overinflate true engagement, retention, and weight losses outcomes of commercially available programs. Thus, to complement the clinical trial literature, ecologically valid studies are needed that examine real-world enrollees in naturally occurring Web-based commercial weight loss programs and, thus, ascertain true program engagement, retention, and outcome data. Results from such studies may be used to inform consumer decision making and public policy.

This study examined the effectiveness of DietBet, which is a commercially available Web-based program that uses social gaming and financial incentives to promote weight loss. Upon enrollment, players join a game and enter money into a pool. All players have 4 weeks to lose 4% of their initial body weight. During the game, players report their weight and interact on the DietBet platform. At the end of the game, all players within each game who lose at least 4% in 4 weeks are declared “winners” and split the initial pool of money bet at enrollment. The primary aim of this study was to conduct a naturalistic examination of engagement, retention, and weight loss outcomes in DietBet. Previous findings from financial incentive weight loss trials have shown that the possibility of losing large (vs small) amounts of money for not meeting weight goals motivates better overall weight loss [10]. In addition, more frequent self-weighing and greater social influence for weight loss have been found to be associated with better weight outcomes [12-15]. Given these findings, we explored whether: (1) betting more money at enrollment, (2) completing more weigh-ins, and (3) having greater social engagement/influence predict greater percent weight loss and greater likelihood of winning. Finally, given evidence that weight loss clusters in social networks and that group characteristics impact weight outcomes in group-based weight loss competitions [12], we also explored whether weight loss clusters within games (ie, players in the same game achieve similar weight loss) and whether game characteristics (eg, number of players) are associated with weight outcomes.

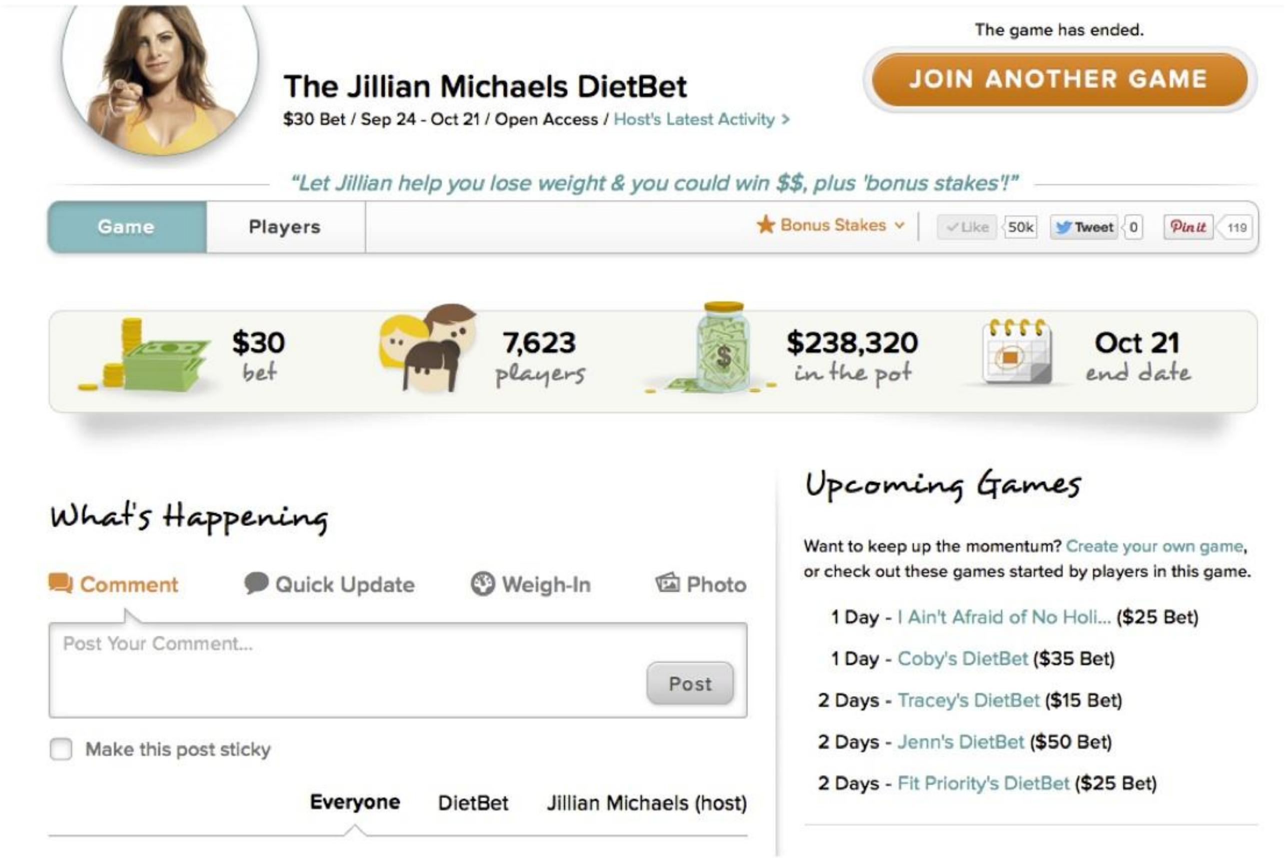
Methods

Procedures

DietBet is a social gaming website that uses financial incentives and social influence to promote weight loss. Players are recruited via press coverage (eg, Today Show, CNN, New York Times, Wall Street Journal), business development efforts (popular wellness experts with social capital are asked to host games and encourage fans/followers to participate), direct virality (players recruit other players), and indirect virality (players share DietBet information on Facebook). At enrollment, players bet money and join a game. Players are given the option to join an existing game that has not yet started or create their own game. If they create their own game, it can be either open (anyone can join) or closed (invite only; ie, all players know each other).

Players are prompted to submit their official start weight two days prior to the start of the game, (see below for weigh-in procedures). Once the game begins, players have 28 days to lose 4% of their initial body weight. DietBet does not promote a specific diet or weight loss strategy; instead, players are allowed to choose any strategy to lose weight (eg, low-fat diets, low-carbohydrate diets, etc). During the game, players post photos, comments, and weight loss tips (Figure 1 shows a screenshot). They are also encouraged to stay accountable to one another by posting their weight loss. Players can view their weight loss relative to the weight loss of others in the game (see Multimedia Appendix 1). To facilitate game communication and sharing, players have access to the DietBet app, which is designed for all smartphone mobile devices and includes all aspects of the gaming platform. At the end of 28 days, players have 48 hours to send in their final weight. All players who lose at least 4% of their initial body weight in 28 days split the pool of money that was bet at the start of the game. For example, if the game consisted of 10 players who each bet US $25 and 4 people won, after DietBet's cut (see below), they would each win US $50. If no one loses 4% of their starting weight, the player who lost the most weight wins the pool of money. Winners are notified by email of their payout, which they can either apply to their next DietBet game or cash out.

Figure 1. Intervention screenshot.



DietBet keeps a portion of the initial pool of money to cover financial transaction costs and staff time associated with weight verification, customer service, and tech support. DietBet's share is taken out of each game's starting pool of money before winners are paid. Thus, players who do not win do not incur a charge to play. DietBet retains 15%-25% of the payout depending on the amount of each individual bet (US $1-$99–25% fee; US $100-$249–20% fee; US $250 or more–15% fee).

Measures

Gender and Weight

Participants report their gender at the beginning of the game. Within 48 hours prior to the start of each game, participants are required to complete an official weigh-in. Similarly, within 48 hours after the end of a game, participants are to complete an official weigh-in. Official weigh-in procedures involve the submission of two photos, one of the player on a scale in light indoor clothing without shoes and another that captures the scale's readout and a piece of paper that includes the player's weigh-in password. DietBet staff reviews each photograph for player-password correspondence. In addition, DietBet uses prespecified algorithms to detect any unusual weight outcomes and game activity; specifically, across games DietBet will identify players who have won more than US $300 in DietBets and identify players who have unusual weight gain between DietBet games (ie, gained more than 1% per day). Those individuals are flagged and DietBet staff completes a detailed review of their weight, game activity, and profile information. Using these algorithms and the photo-based system within 48 hours of the start and end of a game, if a weight is deemed questionable, players are required to submit extra proof by completing a live Skype weigh-in with one of DietBet's referees, a video weigh-in, or an in-person weigh-in at a DietBet approved location (eg, Walgreens drugstores or Customer Value and Service drugstores).

Weigh-Ins, Social Engagement, and Facebook Shares

All weigh-in, social engagement, and Facebook data were obtained directly from the DietBet website. Specifically, during the game, players reported their weight on the DietBet platform and weigh-ins were summed for each player. Players interacted with one another by cheering, posting pictures, posting status updates, "liking" others' posts, and commenting on and replying to posts; to create an overall social engagement variable, the number of social interactions for each variable (cheers, pictures, updates, etc) were summed for each player. DietBet collected data on whether players posted their game participation on Facebook; data were coded 1 for "Yes" or 0 for "No." The option to share on Facebook was not available in early games. Thus, the sample size for this variable is smaller than the overall sample (n=20,059 vs N=39,387).

Money Bet and Won

The amount of money bet and the amount of money won was obtained objectively via payment transaction data.

Game Characteristics

The number of players on each game and whether all players knew each other (closed game/invite only vs open game) were obtained objectively by extracting data from the platform.

Statistical Analyses

Player characteristics, engagement, and completion outcomes were examined using simple descriptive statistics, including means, standard deviations, and percentages. Completers (ie, those who completed an official weigh-in procedure at the end of the game) and noncompleters were compared using analyses of variance or chi-square tests for continuous or categorical variables, respectively. To examine the effects of DietBet on weight loss, a conservative baseline carried forward intention-to-treat approach was used; players who did not finish the game (ie, did not complete a final, verified weigh-in) were assumed to have remained at baseline/entry weight and within subjects *t* tests were conducted. Predictors of weight loss and whether a player won their game were examined with regression analyses. In addition, to determine which variables explained unique variance in weight loss, a multivariate analysis that included all variables was conducted. The effects of game and game characteristics on weight outcomes were also explored. To examine whether weight loss clustered within games, an unconditional multilevel model was conducted and an intraclass correlation coefficient (ICC) was calculated using the resulting between and within group variance components, ($ICC=U_0/U_0+R$).

Ethics

The Miriam Hospital's Institutional review board approved this study.

Results

Engagement and Completion

From December 2012 to July 2013, 39,387 players participated in 1934 games on the DietBet platform. Players were predominantly female (84.04%, 33,101/39,387) with a mean baseline weight of 87.8kg (SD 22.6kg). The average amount of money bet at game entry was US $26.84 (SD US $21.93). Upon enrolling, 50.03% of players chose to share their DietBet participation on Facebook (note–the option to share on Facebook was not available in earlier games, thus the total sample size for this variable was n=20,059, of those n=10,036 shared their DietBet participation). During the 4-week game, players completed an average of 5.3 (SD 3.9) weigh-ins and engaged in 9.3 (SD 78.4) social interactions (eg, cheers, posts, likes, etc).

A total of 71.71% of participants (28,244/39,387) self-reported their weight into the DietBet platform during week 4, and 65.63% (25,849/39,387) completed an official weigh-in at the end of the game (ie, completed the photo-based weigh-in process immediately following the game). A greater proportion of men completed a photo-verified weigh-in than women (Men–68.39%, 4292 out of 6275; Women–65.10%, 21,550 out of 33,101; *P*<.001). Compared to noncompleters, completers weighed less at baseline (87.4kg, SD 22.2kg vs 88.5kg, SD 23.3kg, *P*<.001), bet more money at program entry (US $27.79, SD US $24.99 vs US $25.01, SD US $14.21, *P*<.001), and had more weigh-ins (6.5, SD 4.0 vs 3.0, SD 2.5, *P*<.001) and more social interactions with their teammates during the game (eg, cheers, comments, likes, etc; 12.0, SD 95.3 vs 4.3, SD 22.6, *P*<.001). A greater percentage of completers versus noncompleters shared their game participation on Facebook (50.96%, 7074 out of 13,882 completers vs 47.74%, 2949 out of 6177; *P*<.001).

Weight Loss

Intention-to-treat analyses (assuming that individuals who did not complete an official, photo-based weigh-in at the end of the game did not lose any weight) showed that players lost a significant amount of weight from baseline to the end of the game (*P*<.001; Table 1). The average weight loss was 2.6% (SD 2.3%). Out of the 39,387 players who enrolled, 43.60% (n=17,171) were winners (ie, lost at least 4% of initial body weight or, if no one lost 4%, lost the most weight in their game). The average amount won was US $58.79 (SD US $34.90) (net earnings–US $29.00, SD US $16.43). Game winners lost an average of 4.9% (SD 1.0%) of initial body weight. A total of 30.68% of winners (n=5268) achieved a 5%, or clinically meaningful, weight loss.

Table 1. Player weight loss.

	Total sample (N=39,387)	All winners (n=17,171)	Winners who lost ≥ 4% (n=16,687)	Winners who lost most weight in game (n=484)
% weight loss, mean (SD)	2.6 (2.3)	4.9 (1.0)	4.9 (0.9)	3.4 (0.9)

Participant Characteristics Associated With Weight Loss and Winning the Game

Participant baseline characteristics and game variables predicted weight loss outcomes and whether a player won their game. Significant predictors of greater percent weight loss were male gender (*P*<.001), lower baseline weight (*P*=.03), betting more money at game entry (*P*<.001), completing more weigh-ins during the game (*P*<.001), sharing game participation on Facebook (*P*<.001), and having more social interactions with other players (*P*<.001). These same variables were also significant predictors of whether a player won their game (*P*s<.001; Table 2).

Table 2. Winners' versus nonwinners' baseline characteristics and engagement.[a]

	Winners (n=17,171)	Nonwinners (n=8678)	Winners versus nonwinners (*P* value)
Male, n (%)	3489 (20.32)	803 (9.25)	<.001
Baseline weight kg, mean (SD)	87.1 (22.1)	88.1 (22.4)	<.001
Amount bet US $, mean (SD)	$29.79 ($29.18)	$23.83 ($12.30)	<.001
Shared on Facebook,[b] n (%)	4837 (53.19)	2241 (46.79)	<.001
Weigh-ins, mean (SD)	7.0 (4.2)	5.4 (3.1)	<.001
Social engagement, [c] mean (SD)	13.6 (113.6)	8.8 (38.4)	<.001

[a]Given that completion was associated with baseline characteristics and engagement, to control for potential confounding of completion, only game completers were included in these analyses, n=25,849.

[b]Option to share on Facebook was not available in early games. Thus, the sample size for this variable is smaller than the overall sample of completers. Specifically, of those who were given the option to share on Facebook, n=20,059, a total of n=13,882 completed the game. Of those, n=9093 were winners and n=4789 were nonwinners.

[c]Sum of cheers, comments, replies, likes, photos, and updates.

In a multivariate model, all variables remained significant, independent predictors of weight loss (*P*s<.001) with the exception of number of social interactions and whether a player shared on Facebook (*P*s>.38).

Game Characteristics and Social Network Factors Associated With Weight Loss

The 39,387 players represented a total of 1934 games. Weight loss tended to cluster within games (*P*<.001; ICC=.07, consistent with a small effect) [16], suggesting that a player's weight loss was influenced by other players' weight loss. On average, there were 31.4 (SD 171.2) players in each game. Game size predicted weight loss; larger games were associated with greater weight loss (*P*<.001). Games in which players knew one another had slightly more social interactions than games in which players did not know one another (ie, invite only/closed games vs open games; 4.9, SD 6.1 vs 4.1, SD 5.1, *P*=.001); however, weight loss outcomes were not affected by whether players knew one another at the start of a game (*P*=.74).

Discussion

Summary of DietBet Engagement and Weight Loss

DietBet, a 4-week commercial Web-based program for weight loss, yields retention results that are comparable to other programs [9,17] and produces excellent engagement and weight loss. On average, participants interacted with other players on the DietBet platform more than twice a week and reported their weight loss at least once a week. A total of 71.71% of participants (28,244/39,387) submitted a self-reported weight at week 4 and 65.63% (25,849/39,387) completed final, photo-based weigh-in verification procedures. Average intention-to-treat weight loss was 2.6%, and 42.39% of players (16,696 out of 39,387) achieved the 4% weight loss goal. Moreover, over 5000 participants (n=5268) achieved a 5%, or clinically meaningful, weight loss.

Comparison of DietBet Results to Other Internet Commericial Weight Loss Programs

DietBet results compare favorably to other Web-based commercial programs and to more intensive programs. In reports of the Biggest Loser Club, participants self-reported their weight loss less than once a week [18], social engagement was low (median interactions=0, range 0-0) [18], and overall weight loss ranged from 2% to 3% [9,18]. Similarly, reports on the eDiets program indicate low engagement and modest weight loss (1% to 3%), even when combined with in-person visits and when evaluated in a randomized trial that would presumably improve adherence and outcomes [8,11]. Given that the Biggest Loser Club and eDiets are longer programs (3- and 6-months, respectively) and that weight loss steadily increases during the initial 4 to 6 months of treatment [19], these earlier programs would be expected to yield a greater magnitude of weight loss than DietBet. Instead the one month weight losses produced by DietBet are as good as, if not better than, those produced by 3- and 6-month programs. In fact, they are comparable to weight losses achieved during the initial four weeks of university-based, intensive behavioral weight loss programs that involve weekly in-person meetings led by professional staff [19]. While these results are promising, in order to draw more definitive conclusions regarding the weight loss produced by DietBet versus other commerical weight loss programs, the length of DietBet needs to be extended so that it is more consistent with the length of these longer, more intensive commerical weight loss interventions.

Explaining DietBet Results: Behavioral Economics, Social Influence, and Self-Monitoring

The favorable outcomes produced by DietBet may be attributed to its social gaming components-namely, the use of financial incentives and social influence. Results showed that those who bet more money and had greater social engagement had a greater magnitude of weight loss and were more likely to "win" their game. These findings are consistent with those from behavioral economics and with findings in the behavioral weight loss literature. Behavioral economics suggests that loss aversion (the strong tendency to avoid losing something that is owned) is a significant motivator of human behavior and that the magnitude of loss may moderate the effect, with greater potential loss yielding greater motivation [20]. Consistent with this theory, in several randomized trials Jeffery et al showed that behavioral weight loss programs involving deposit contracts (participants deposited money and got it back for meeting goals) yielded significantly greater weight loss relative to the same behavioral interventions without such contracts [21,22]. Moreover, participants who deposited more money at baseline, and could have therefore lost more money, were more likely to reach weight loss goals [22]. There is also strong evidence that combining financial incentives with social influence further improves outcomes. Specifically, randomized trials have shown that group incentives for meeting weight goals, either collaborative or competitive, are more effective than individual incentives [14,21,23]. Thus, the excellent weight losses, retention, and engagement produced by DietBet are likely due to its use of principles from behavioral economics and its inclusion of financial incentive and social influence strategies. Given this success, future Internet interventions, commercial or otherwise, may consider harnessing financial incentives and social influence for weight loss to promote optimal outcomes.

Players who reported their weight loss more often also lost more weight. Not only is regular reporting indicative of better program engagement, which alone is associated with better outcomes [13], but regular weighing is also linked to better weight loss results [24], likely via the process of self-regulation [25]. Specifically, getting on the scale on a regular basis yields important information on whether weight loss efforts are working and, if not, communicates the need to reduce dietary intake and increase physical activity to reach weight goals. Thus, consistent with intervention recommendations from university-based behavioral weight loss programs, DietBet players weighed themselves an average of at least once a week, which likely contributed to the positive weight loss results achieved.

In addition to examining individual effects, we also explored the effects of game characteristics on outcomes. Consistent with previous findings showing that weight loss clusters in team-based weight loss competitions [12], individuals in the same game tended to achieve similar weight losses, suggesting social influence for weight loss among players. In addition, games with more players achieved greater weight loss overall. While previous research shows that group size does not affect weight loss outcomes in group-based interventions [12], this earlier study did not involve incentives. However, this earlier study did not involve incentives. Consistent with the behavior economics principle that reinforcement size is positively associated with response strength [26], the larger pool of money inherent in bigger games may have motivated players to lose more weight to, thereby, “win” their game. Interestingly, player familiarity created by “invite only” games (vs open games) did not affect weight outcomes. Combined with the clustering effect, these results suggest that games are able to effectively create social influence and promote social interactions for weight loss even among strangers.

Study Limitations

Study limitations include a predominantly female sample, lack of some player characteristic data (age, race, ethnicity, etc), the short program length, and lack of fully objective weight data. Majority female participation is common in weight loss trials and commercial weight loss programs [8,9,18]; however, given the prevalence of obesity in men [2], future DietBet games may consider using targeted advertisements to increase male enrollment. Additional player information (eg, height, age, race, ethnicity) would help to better describe the large sample of individuals who enrolled in DietBet and make comparisons between the DietBet population and populations of other Internet commercial weight loss programs; DietBet has begun to collect such information on new enrollees. The program length was 4 weeks; while players achieved excellent weight losses in this short period of time, and there is evidence that initial weight loss is predictive of future success [27], a longer program is warranted. As such, DietBet has developed and launched a longer, 6-month game, which will allow us to examine magnitude of weight loss produced over a longer timeframe. Finally, while the DietBet weigh-in system is more rigorous than the self-report methods used in other commercial programs [19], a systematic validation study comparing the DietBet photo-based weigh-in system to objective weights obtained from unbiased assessors is warranted.

Study Strengths

This study has several strengths. It provides a reliable and ecologically valid examination of the true engagement, retention, and weight loss achieved in DietBet, a wide-reaching, commercial, Web-based weight loss program that uses financial incentives and social influence to promote weight loss in large numbers of individuals. Only a small number of studies have conducted a naturalistic examination of such programs. Moreover, these previous studies have obtained only self-report weight [17,18,28]. In contrast, the weigh-in procedures used in DietBet were not solely reliant on self-report; instead, players were required to provide photo-based weight information and rigorous weight verification procedures were employed, with human referees reviewing multiple photos per player. Moreover, as indicated by the Federal Trade Commission, the data provided herein are critical to consumers who are inundated with Web-based weight loss options, but have limited information on effectiveness [29]. Finally, and perhaps most importantly, given that DietBet was able to reach nearly 40,000 individuals in just 7 months and, with the use of financial incentives and social influence, engage players and produce promising weight losses, DietBet may have the potential to impact public health and help address the epidemic of obesity.

Acknowledgments

The authors would like to acknowledge all DietBet staff and players who made this report possible.

Conflicts of Interest

Mr Rosen is the chief executive officer of DietBet, Inc and receives salary support from the company.

Multimedia Appendix 1

Intervention screenshot of player progress.

[PNG File, 66KB - games_v2i1e2_app1.png]

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Abbreviations

ICC: intraclass correlation coefficient

Edited by G Eysenbach; submitted 27.09.13; peer-reviewed by C Collins, J Nunez-Cordoba, K Hwang; comments to author 30.10.13; revised version received 11.12.13; accepted 11.01.14; published 07.02.14.

Please cite as:
Leahey T, Rosen J
DietBet: A Web-Based Program that Uses Social Gaming and Financial Incentives to Promote Weight Loss
JMIR Serious Games 2014;2(1):e2
URL: http://games.jmir.org/2014/1/e2/
doi:10.2196/games.2987
PMID:25658966

Original Paper

Views of Young People in Rural Australia on SPARX, a Fantasy World Developed for New Zealand Youth With Depression

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Abstract

Background: A randomized control trial demonstrated that a computerized cognitive behavioral therapy (cCBT) program (Smart, Positive, Active, Realistic, X-factor thoughts [SPARX]) was an appealing and efficacious treatment for depression for adolescents in New Zealand. Little is known about the acceptability of computerized therapy programs for rural Australians and the suitability of computerized programs developed in one cultural context when used in another country. Issues such as accents and local differences in health care access might mean adjustments to programs are required.

Objective: This study sought to explore the acceptability of SPARX by youth in rural Australia and to explore whether and how young people would wish to access such a program.

Methods: Focus groups and semistructured interviews were conducted with 16 young people attending two youth-focused community services in a small, rural Tasmanian town. An inductive data-driven approach was used to identify themes using the interview transcripts as the primary data source. Interpretation was supported by demographic data, observer notes, and content analysis.

Results: Participants reported that young people want help for mental health issues but they have an even stronger need for controlling how they access services. In particular, they considered protecting their privacy in their small community to be paramount. Participants thought computerized therapy was a promising way to increase access to treatment for youth in rural and remote areas if offered with or without therapist support and via settings other than school. The design features of SPARX that were perceived to be useful, included the narrative structure of the program, the use of different characters, the personalization of an avatar, "socialization" with the Guide character, optional journaling, and the use of encouraging feedback. Participants did not consider (New Zealand) accents off-putting. Young people believed the SPARX program would appeal to those who play computer games generally, but may be less appealing for those who do not.

Conclusions: The findings suggest that computerized therapy offered in ways that support privacy and choice can improve access to treatment for rural youth. Foreign accents and style may not be off-putting to teenage users when the program uses a playful fantasy genre, as it is consistent with their expectation of fantasy worlds, and it is in a medium with which they already have a level of competence. Rather, issues of engaging design and confidential access appeared to be more important. These findings suggest a proven tool once formally assessed at a local level can be adopted cross-nationally.

(JMIR Serious Games 2014;2(1):e3) doi:10.2196/games.3183

KEYWORDS

mental health; stigma; computer games; youth; rural health, computerized CBT

Introduction

Northwest Tasmania is characterized by mountainous terrain, a rugged coastline, and small, sparsely populated settlements with economies reliant on agriculture, mining, and forestry. These communities are too small to individually host a full range of community health services and in winter they are often isolated due to flooding, high winds, snow fall, and icy roads. It is these smaller towns and settlements where social determinants associated with health inequity are most evident, that have reduced access to health services, have a higher proportion of Aboriginal Australians, lower socioeconomic status (SES), and are under-represented in post school education statistics [1,2]. Recent investment in Internet infrastructure in the region has provided an opportunity to support communities and augment existing services with Web-based interventions.

The impact of child and adolescent mental health disorders on individuals, families, and communities is significant [3,4]. Loss of engagement at school, increased substance abuse, family conflict, and teenage pregnancy are common comorbid associations [4-6]. Early intervention with cognitive behavior therapy (CBT) for young people with depression has been shown to be effective in reducing mental health symptoms [6-9]. Tasmania has the second highest risk of suicide of all Australian states, with an apparent urban-rural gradient for males (which places rural males at increased risk) [3]. As 75% of adult mental health disorders begin in childhood, getting help to young people early has important clinical, social, and political implications [4,10]. Of all the various indicators of SES, low household income and low parental education were found to be the strongest predictors of mental health problems among children and adolescents, with greater impact in early childhood [2]. Young people in rural areas are particularly vulnerable; as a higher risk population, they are less likely to seek help due to their social visibility (ie, the perception that they will be seen accessing health services and this will not remain confidential), and they have fewer services available to them [6,11,12]. There is also disparity in the quality and outcomes of psychiatric care for vulnerable populations, which include ethnic minorities, rural communities, and people of low SES [5,12-15].

Traditional approaches to translating evidence-based interventions into practice have failed to substantially close the gaps in service quality or reduce disparities [16-18]. Alegria et al [18] suggested the limited impact of evidence-based interventions in vulnerable communities may be due to not accounting for community and cultural contexts, such as infrastructure realities (eg, lack of staffing or access to services, and community cultural norms), focusing on individuals without using community resources to support implementation, research findings being disseminated primarily through scientific journals rather than directly to communities, and the gold standard for clinical research, the randomized clinical trial, emphasizing internal validity over external validity, or generalizability, and often excluding vulnerable populations [18].

Computerized therapies have been shown to be effective in alleviating depression and anxiety symptoms in adults, adolescents, and children [19-22]. Most of the available programs online are text-based, with limited interactivity, relying on higher levels of literacy. Efficacy studies of computerized CBT (cCBT) have noted issues with user engagement and high attrition of users [19,23-25]. Interestingly, program specific design features are widely considered in human computer interaction research and in the field of serious gaming [26], but have received little attention in studies of cCBT.

Smart, positive, active, realistic, X-factor thoughts, or SPARX, is a cCBT program that uses a bicentric frame of reference [27]; it combines an exocentric virtual therapist to provide observer perception and reflection with an egocentric game component, which immerses the user in participation through accomplishment of a series of tasks. SPARX engages the user in a fantasy-based world, where the user travels to 7 different provinces to undertake CBT-based challenges and to develop skills [28]. A narrator or “Guide” supports the user throughout the program, and provides encouragement and dialogue promoting the idea that depression is treatable and that by making some achievable changes the user will feel better. The efficacy of SPARX has been assessed by a randomized control trial with New Zealand youth aged 12-19 years accessing help for their depression from primary health care sites [28]. SPARX was shown to be at least as good as usual care (primarily counseling delivered face-to-face with a mental health clinician) [28]. Youth trialing the SPARX intervention also reported a high level of satisfaction and engagement with the program [29,30].

This research project was undertaken as a first step in exploring the “translation” of a computer program developed for New Zealand youth, for use by young people in rural Australia. Issues such as accents and local differences in health care access might mean adjustments to programs are required. Given that (un)acceptability of Web-based programs is a significant factor in attenuating the effectiveness of services delivered in real world settings as compared with efficacy shown in clinical trials it is an important component to assess for methodological and pragmatic reasons [31]. While there is no one definition of acceptability, common sources of information about acceptability, include take-up and dropout rates, reasons for dropout, and patient attitude and satisfaction toward an intervention [31]. Given the exploratory nature of this study acceptability was assessed in terms of general expressions of interest by participants in the use of the program in its current form for self or other, and the suitability of the mode of delivery. This is of interest as issues of dissemination of computerized programs outside of the group that they were designed for are seldom explicitly considered.

Methods

Geographical Selection

To engage with the community to assess the acceptability of the SPARX cCBT program (look, sound, and feel) to Australian youth, a naturalistic ontological view was adopted. A naturalistic, or subjective ontology, considers the researcher part of the same experience as the research participants, not discrete from the inquiry. The nature of the research is exploratory; the researcher seeks to understand the reality, actions, and perceptions of individual participants. This is not assumed to be value-free, but interpreted by the researcher [31], an approach consistent with understanding the perspective of local youth on the SPARX program and the need for any visual or verbal components of the program to be "reskinned" (ie, characters, sound, or language in the program changed from the New Zealand context, which includes a range of Maori, Pacifica, Asia, and Anglo ethnicities, to be more relevant to young people living in northwest Tasmania).

A decision to adapt the program would incur cost, thus evidence to support the decision required a degree of impartiality by the researcher. On this basis, a positivist epistemology was applied. Positivist epistemology asserts the researcher has a priori relationships with phenomena, which may be identified and tested by logic and deduction [32]. That is, outcomes may be hypothesized and tested based on predicted causality. The positivist view assumes a value-free and unbiased researcher. Where it is accepted, information systems are inherently a relationship between technology and the social world, value-neutrality cannot entirely exist. Instead, it is argued that paradigms should not be rigid and fixed, but should allow different methods, which are appropriate for the different situations [33,34]. By adopting a less predefined and circumscribed stance, the positivist researcher is open to discovering and understanding nondeterministic variables, which is considered a more valuable inquiry of social systems [34].

As only a small window into local youth opinion was required, both to suit the nature of the inquiry and the way young people were most likely to interact, short focus groups were selected as the primary data collection method, supported by demographic information, observer notes, and content analysis.

One of the small rural towns of northwest Tasmania was selected for the study, which is characteristic of the vulnerable, small communities described. There is one General Practice in the town, no resident psychological service, with a visiting mental health practitioner hosted 1 day per week at a local organization. The nearest regional town with psychology services is over 80 km (50 miles) away; the nearest Headspace office (National Youth Mental Health Foundation offering specialized mental health services for 12- to 25-year olds) is over 200 km (125 miles) away. According to the 2011 Australian Bureau of Statistics Census data [35], the town has a population of 3935, 14% of whom identified as being of Aboriginal or Torres Strait Island origin (compared with a national average of 2.5%), and 15% are aged between 10- and 19-years old. The median weekly household income is AUS$893.00 (5.8% less than the Tasmanian median of $948.00 and 27.6% less than the Australian median of $1234.00). Only 39% of the towns' population over 15-years old has a post school qualification, compared with 55% of the Australian population.

The two community-based organizations in the town offering a variety of community programs aimed at improving the towns' health and well-being supported this study. These organizations focus on early intervention and preventative measures to encourage and enhance healthy life and seek to improve quality of life and wellbeing for individuals and families. A range of services are available, including mental health support, health promotion and education, and youth health. One organization supports all persons in the community regardless of their social, mental, or physical condition and generally operates as a self-referral service, although troubled youth are steered to these services through school programs. The other organization specifically targets services to meet the needs of the local Aboriginal community, but also includes referrals from police to youth prevention and diversion programs. The visiting mental health practitioner is hosted by this organization through a Medical Specialist Outreach Assistance Program. As such, these organizations do not represent the broader community of young people, but provide a more purposive sample for assessing an adolescent mental health intervention by means of a focus group interview. Ethics approval for conducting this research was obtained from the Tasmanian Social Sciences Human Research Ethics Committee.

Recruitment

Both organizations preferred to recruit potential participants themselves, and arrange groups to optimize dynamics based on their knowledge of the individuals. Three participants were recruited from one of the organizations, 2 males and 1 female (these participants did not want to participate in any of the second community organization groups because they did not feel comfortable in an alternative setting. They also wished to have gender-specific groups). The research team determined it was important to capture the views of marginalized individuals and we were, therefore, keen to accommodate these preferences. Hence, semistructured interviews were carried out with the 2 male and 1 female participants.

The second organization recruited 10 males and 3 females. Again, this organization's staff felt the individuals would best participate in groups according to gender, and organized their participants into a younger male group (with participants 12- to 15-years old), an older male group (with participants 16- to 18-years old), and a group for females.

Conducting the Focus Groups

The focus groups were held at the participating organizations in consecutive weeks, with an information session held the day before each focus group. At the beginning of the focus group sessions participants were asked to record their age, gender, ethnicity, and whether or not they played computer games.

The SPARX program was introduced by using a short (5 minute) video trailer of the program. The trailer included audio of the Guide character supporting a program user, avatar customization, and the visual effects of being transported into the SPARX fantasy world (Figures 1 and 2). Following this, three PowerPoint slides were shown, which illustrated 4 of the program's "provinces", the tasks to be completed in those provinces were described, and the personal journal/user notebook was demonstrated. The focus group was also asked a list of questions to help evaluate SPARX, outlined in Textbox 1.

The clinical psychologist of the research team (HB) acted as the Facilitator, while another member played the role of Observer (CC). Neither were known to participants prior to the information sessions.

Figure 1. SPARX guide.

Figure 2. All SPARX characters.

Textbox 1. Predefined questions to initiate open-ended discussion.

1. What do you think of the way SPARX looks?
2. What do you think of the way SPARX sounds?
3. Do you think young people around this area might be interested in using the program? If so, why? If not, what about if they were feeling down or depressed?
4. If young people were to use SPARX, where might they use it (eg, at home, school, etc)?
5. What do you think might get in the way of young people using SPARX?
6. Do you think any changes need to be made to SPARX so that young people would like to use it? If so what could be changed? How important would it be to make these changes?
7. What do you think about the use of the word "Depression"?

Analysis

As this was a small study, a hybrid approach in developing a data-driven code was followed as described by Boyatzis [36]. In the first stage all interviews were used in the development of the themes and coding framework, negating the need for sampling to model coding. In the second stage, our own theories (CC, HB) were used as a means to articulate meaningful themes, replacing comparison of themes across samples. Coding the rest of the raw data was not required as the interviews were not sampled.

Thus, to systematically conduct thematic analysis, the procedure followed in this study was in two stages:

1. Identification of the dependent variable and use of all 5 focus groups/interviews
2. Development of themes and codes
   - Reduction of the raw data
   - Identifying themes within samples
   - Comparison of themes to own theories and research literature
   - Creation of a code
   - Checking reliability by revision and refinement of category system

Audio recordings of the interviews were transcribed using Olympus Sonority v1.2.0 voice recording software. The transcripts were entered into Microsoft Excel 2010 software for organization, identifying the group, gender, and age of participants. Observer notes and content analysis were added at the appropriate questions. Blocks of text were summarized according to the specific interview question and research aim (Table 1). Transcripts were then compared and similarly themed summary text was grouped (Table 2).

Emerging themes were identified through repetition of a common word or action, for example "privacy" or "using it in private/at home/where no one else can see". The views of gamers were subsequently compared with nongamers to understand how a prior interest in computer gaming might affect their view of SPARX, and within the context of the personal sphere of participation for meaningful use of technology in health [37].

Sixteen codes were generated. To identify categories, an iterative grouping process was used where the codes were at times split, and regrouped with indicators and text fragments as examples to find where they best represented the themes and data within, and to select category labels that best represented these. Once these categories were established as nodes and subnodes within nVivo software, the transcripts were recoded according to this framework by members of the research team individually (CC, HB). This double-coding technique sought to test the reliability of the coding framework. Reports were compared and reviewed collectively to discuss and resolve differences. The revised final category system, themes, and transcripts were reviewed (TF) and found to be similar to information derived from SPARX-related focus groups previously conducted with young people in alternative education programs [30].

Table 1. Excerpt of summarized block of text from focus group 1 interview in Microsoft Excel (boys, gamers, age 13).

Line	Speaker	Quote	Field notes	Summarized text
10	R	*What about how the characters sound. Any feedback about that?*		
11	Y1	*Well, one of them sounded a bit like a Kiwi*		The New Zealand (Kiwi) accent was identified by 1 of the 5 participants, but in general it was not thought to be important by the group.
12	R	*A bit like a Kiwi. Did anyone else notice that?*		
13	Y2	*No*		
14	Y3	*No*		
15	Y4	*Na*		
16	Y5	*Na*	1:5[a]	
17	R	*OK. Do you think other people would notice that they sound a bit like a Kiwi?*		
18	Y1	*Probably, I don't know*		
19	R	*Do you think it would bug people?*		
20	Y1	*No*	*Same person who identified Kiwi accent*	
21	Y2	*Not really*		
22	R	*Not really?*		
23	Y3	*It's not very important*		

[a]1 out of 5 participants noticed one voice actor sounded "Kiwi".

Table 2. Groups of similarly themed summary text.

Group	How does the program sound?
1	Five of 6 participants said it sounded like it was for an audience of Grade 7-8 (12-14 y); having text displayed as well as the audio was helpful.
2	The New Zealand (Kiwi) accent was identified by 1 of 5 participants but in general it was not thought to be important by the group.
3	The group thought it sounded okay and were happy with the voices. They did not think any changes needed to be made. If it was to be "Australianized", 1 participant (nongamer) thought an Australian accent would be more attractive to local youth, but if the choice was between not having the program or having the program with the current accents all 3 would choose to have the program as it is
4	Thought it sounded "Cool"
5	Thought it was "OK"

Results

Demographics

Five focus group/interview sessions were held with a total of 16 participants, (12 male and 4 female) between the ages of 13- and 18-years old. Four participants reported their ethnicity as Aboriginal, 5 as Australian, while 7 reported none or left this field blank. Thirteen of the 16 participants identified themselves as a computer gamer (Table 3).

The categories derived from thematic analysis of the data were personalization, engagement, and stigma.

Table 3. Participant self-reported demographics.

Group/session	N	Gender		Age						Ethnicity			Computer Gamer	
		M	F	13	14	15	16	17	18	Aboriginal	Australian	None	Yes	No
1	4	4		4								4	4	
2	6	6				2	1	2	1	1	5		6	
3	3		3	1	2					3			2	1
4	1		1		1							1	1	
5	2	2			1		1					2		2
Total	16	12	4	5	4	2	2	2	1	4	5	7	13	3

Personalization

Having options to make personal choices was consistently valued across all groups with all participants, "because everyone's really different." [Male, 15- to 18-years old]

Table 4 outlines some of the ways choice was valued and examples of how this was expressed.

Additionally, the participants accepted that while some people would value being able to use the program in private, without telling anyone, others would prefer to use it with a counselor, to augment counseling sessions, or to use the program in a group therapy session, "It'd probably be like a bit of a first step, like they go through that [SPARX], then they they'd go to a counselor sort of thing." [Male, 15- to 18-years old]

The personalization of the program itself was also seen to be important. This was strongly represented in comments relating to the choice of gender of the avatar, with both males and females suggesting making the gender of the guide a choice for users. The importance of this choice was not just for aesthetics, but because the young person might not relate well to the gender seen as being the cause of, or contributing to, the young person's issues in real life.

The ability to recommend this program to friends who might not otherwise agree to see someone for help was also valued by the groups.

Table 4. Valued choices on ways to get help and supporting quotes.

Choice	Quote
1. Choose how they got help, who to tell, or choosing not to tell or be reliant on anyone in order to get help	*They don't really have to talk to an actual person about it, and that way they don't have to worry about getting judged with the feedback and stuff like that.* [Male, 15- to 18-years old] *Brothers and sisters mightn't know that you're feeling that way, and you may not want them to know.* [Male, 13-years old]
2. Choosing when and where they could use the program	*You know… go home and play it all night all day and stuff.* [Female, 14-years old]
3. Being able to get help outside of a counseling session	*If they have a counselor or someone like that, they can recommend it if they don't see them very often. Because say, like once a week and the person doesn't feel like that's enough, they could go to this program.* [Male, 15- to 18-years old]

Engagement

This theme referred to young people's access to and use of computers in general and their acceptance of the SPARX computer game as a tool to deliver health care. All participants used computers, and some specifically identified they used computers when they were feeling down. Participants either identified as people who usually played computer games or not. Most (13 of 16 participants) played computer games. Those who played computer games were very accepting of this program:

> *It's just cool… it's a different way... because you know, you go to a counselor and stuff and they have all these different ways of doing things but like, nobody's ever really thought of a computer game or something. It's usually like "tell me how you're feeling", or "write it down" and stuff, but not "play it".* [Female, 14-years old]

Those who did not play computer games said they would be less likely to engage with the SPARX program. One nongamer was quite vocal within her group and open about her lack of interest in this medium as a way of getting help, "To be honest, I hate computer games. Some people like me—I wouldn't want to play a game." [Female, 13- to 14-years old]

This allowed comparison of her responses to others. For example, her view of a fantasy-based genre was different than others, which is outlined in Table 5.

Table 5. Female responses to game genre.

Speaker	Quote
Researcher	*If you were looking for help would you want fantasy or real?*
Group 3 female nongamer	*Modern*
Group 3 female gamer	*Fantasy - I think that look is really cool*
Group 4 female gamer	*It's really cool and it's cool how you meet different people, like the travelers pop up and stuff*

While some recognized that the Guide had a New Zealand ("Kiwi") accent, they also stated that this was not important (Table 2). The most consistent response to the question about proposed changes for the program was to provide an option to change the gender of the Guide. The importance of this change, when offered on a scale of 0-10, with 0 being not at all important, and 10 being very important, ranged from 4-8. When asked if it was more important to make these changes or make the program available as is, all were emphatic that it was more important to "get it out there." [Female, 13- to 14-years old]

School was not favored by any group as a place to use SPARX for fear of school peers finding out that a young person was having personal problems and reacting in a negative way. The fear of reprisal was so large some participants stated they would not stop to read posters advertising the program around their school because of its focus on mental health-related issues:

> *Not a lot of people would want to stop there, if it was something like that [SPARX]. Someone will say, "Why are you looking at that?", "Why do you need that?" There's a lot of bullying around.* [Female, 13- to 14-years old]

While most reported that they would use SPARX in the privacy of their own home:

> *Yeah because if it's fully online – people don't like people knowing about their problems, so they'll be judged. So we'd do it in private [at home].* [Male, 15- to 18-years old]

Some identified alternative safe places in the community:

> *The Online center; somewhere like that but with a bit more privacy.* [Male, 13-years old]

Females stated that boys did not like to talk explicitly about their feelings, so this medium potentially offered them an alternative way to explore their feelings safely without having to talk to others, and get the help they needed (perhaps without even realizing it). Boys did comment that some people didn't like talking about their problems, and that the program would be easier than going to a counselor. While the cCBT medium allowed users to get help without having to divulge their thoughts and feelings to others, the narrative of the game and use of different characters was identified as providing an element of socialization and "life" to the program:

> *I like how you've got that Guide and that you can personalize yourself. Like the journal thing - that's pretty cool.* [Male, 15- to 18-years old]

Table 6 outlines three of the reasons why participants were interested in receiving help through a computer game-like medium.

Table 6. The reasons why participants were interested in receiving help through a game-like medium, and examples of how this was expressed.

Reason	Example Quote
1. It is a medium that is known and accessible to them	*Lots of people play games on the computers and in gaming systems.* [Female, 13- to 14-years old]
2. They use computers anyway to feel better	*When I'm feeling a bit sad or down, I just hop on the computer really.* [Male, 15- to 18-years old]
3. It is a nonthreatening way of getting help	*A lot more fun for them too...easier for them to deal with whatever's going on through a game.* [Female, 13- to 14-years old]

Stigma

The stigma of depression and fear of being judged negatively by others was very apparent across all groups/sessions in this study. It was described by participants as the reason young people do not accept they have symptoms and need help, and as preventing them from asking for assistance:

> *Some people don't like to talk about [depression or mental health issues], to people about their problems. It's too embarrassing… like they're useless.* [Male, 15- to 18-years old]

Participants also commented that health professionals were sometimes reluctant to accept a young person had a problem and needed help, further limiting the young person's confidence in asking for help, "Because different professionals sometimes, sometimes they're in denial, because they don't think you're depressed at all." [Male, 15- to 18-years old]

The effect of stigma and their visibility in a small town was evident at a manifest and latent level. In response to a comment that there were free counselors available, a participant commented, "That doesn't always help." [Male, 13-years old]

Another participant related her experience of using online chat sites instead of using local practitioners, "because it's not in the town where everyone can just tell everyone." [Female, 14-years old]

Discussion

Principal Findings

In this exploratory focus-group study, we found that participants wanted help for mental health issues, but there is a stronger need to have choices available to them and to control how they access services. They considered protecting their privacy and visibility in their small community to be paramount. They saw online therapy as providing a number of features that promise this control, getting help without having to tell anyone, and getting help without physically seeing a person or attending a place known in the community. Participants considered the SPARX cCBT program to be appealing and engaging to young people. Design features such as the personalization of an avatar, the socialization with the Guide and other characters, journaling, and the use of encouraging feedback were seen as engaging and helpful. Despite the fact that it was not an Australian program it was considered to be appropriate for local youth. SPARX, in a "playful" medium and using a fantasy-based genre, is a format like other computer games, which many young people like to play and are likely with which to have a level of competence. In this format, young people are accepting of differences in the look and sound of characters.

Previous research has identified that young people often do not seek help from health providers for mental health concerns even if they are concerned about these issues [38-40]. The present findings underscore that rural youth wish to have choices, autonomy, control, and privacy in accessing mental health services. They view Web-based resources as an important opportunity to address this.

It is of interest that young people wished to be able to use the program in private or to be able to use it with a counselor or in a group. In a domain in which an empathetic and supportive relationship with a counselor is a mainstay of therapy, computerized therapies have been regarded warily by practitioners [2,41,42]. In a 2013 study of Australian rural clinician views on using computerized mental health therapies, while most supported the concept, models in which programs were used in conjunction with traditional face-to-face therapy were preferred [42]. Youth in the present study included this model as one of several ways the program should be available. However, they also considered that alternative methods of access should be offered to reflect the different ways people prefer to get help. This is consistent with findings from Fleming et al [30] when exploring the views of young people alienated from mainstream education. The SPARX trial in New Zealand demonstrated that SPARX can be effective with minimal input by a clinician as only research assistants were involved [28].

School is considered an important part of the social life of young Australians; playing a key role in providing help services and the opportunity to use select interventions with extensive reach [12]. The views of participants in this research, however, suggest local schools are not a safe place for them to be openly receptive to communication or interventions for mental health issues. This not only indicates the stigma of depression in the community remains high, but also raises an issue about how to disseminate information on available programs. Restricting access to online therapies for use only in conjunction with clinicians or at school may limit its potential and perpetuate young peoples' reluctance to seek help.

The finding that the SPARX program was appealing is consistent with the popularity of computer games using a fantasy-based genre, which has been reported to comprise over 80% of the gaming market [43,44]. However, it is important to note that SPARX is not a computer game and is unlikely to be considered appealing to a general audience alongside other computer games. Rather, SPARX is a therapeutic tool, which has used a playful interface to increase engagement with young people. User attrition has been an issue in trials of many self-help programs [23-25]. Aspects of appealing design and engaging program features are worthy of explicit consideration. It was of interest that the New Zealand accents and graphics in SPARX did not affect the acceptance of the program in this rural Australian population. All considered, having SPARX available is more important than any changes that might customize it to local culture. In fact, if there were to be changes to SPARX, other changes (eg, being able to choose a male or female guide) were seen as more important than regional accents.

Strengths and Limitations

Where community participation is considered important, introducing some bias may be a trade-off. While participants were not selected on the basis of any objective mood measure, the youth workers did know the individual participants better than the research team, and as such were able to seek out a purposive sample. Most participants said they had felt down in recent weeks. As a step in translating evidence-based therapy into practice, it relies on finding evidence of meaningful use and advocating value from the perspective of vulnerable groups, rather than performing dispassionate science. Nevertheless, quantitative measures were used to support or refute interpretations, and accepted methods of systematic process and analysis were employed and explained.

The small sample size and single-community setting for this research makes this study just a small window into the views of local youth; the focus groups were exploratory and as such the findings of this research do not profess generalizability or offer authority.

Implications

This research has demonstrated that a proven tool can be adopted when the context has changed. Limitations such as accent have little effect when the medium is known and the tool has high fidelity. Young people like computer games. This playful medium offers a nonthreatening way to explore identity and express feelings, in a format that is hugely popular and could overcome literacy barriers and cultural specificity through narration and fantasy-based worlds.

In spite of recent investment in local Internet infrastructure, in 2011 only 65% of northwest Tasmanian dwellings were connected to the Internet, falling to 62% in some west coast towns, in comparison with 74% of Australia [35]. While youth indicated a preference to use this type of program at home, more safe places must be found as part of community implementation. Other options offered by participants included the Internet access center or youth centers, but safe places are likely to vary between communities.

Conclusions

Adolescents have strong views about the dissemination and content of mental health treatments and these views should be considered in the development of services. Computerized CBT therapy offered with and without therapist support and via settings other than school was seen by young people as a promising way to increase access to treatment for rural and remote youth. The game-like interface offered by the SPARX cCBT program was appealing to Tasmanian youth and making the program available was seen as more important than making any modifications to it. It may be an interesting coincidence that fantasy-based computer games have world-wide appeal, but it is an exciting prospect for expanding the reach of evidence-based therapies to more communities.

Acknowledgments

We would like to thank the young people who participated in the study. This study was supported by the University of Tasmania Rural Clinical School and Department of Rural Health. The authors would like to acknowledge Professor Sally Merry, Dr Karolina Stasiak, and the team at the University of Auckland's Werry Centre for Child and Adolescent Mental Health in New Zealand in developing SPARX and making it available to try, and Kathryn Cross for assistance with preparing for and conducting the Focus Groups.

Conflicts of Interest

TF, ML, and MS are codevelopers of SPARX, the intellectual property for SPARX is owned by Uniservices at The University of Auckland and the developers can benefit financially from commercialization of it.

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Abbreviations

CBT: cognitive behavior therapy
cCBT: computerized cognitive behavior therapy
SES: socioeconomic status
SPARX: smart, positive, active, realistic, X-factor thoughts

Edited by G Eysenbach; submitted 14.12.13; peer-reviewed by C Sinclair, C Hawke; comments to author 06.01.14; revised version received 17.01.14; accepted 18.01.14; published 18.02.14.

Please cite as:
Cheek C, Bridgman H, Fleming T, Cummings E, Ellis L, Lucassen MFG, Shepherd M, Skinner T
Views of Young People in Rural Australia on SPARX, a Fantasy World Developed for New Zealand Youth With Depression
JMIR Serious Games 2014;2(1):e3
URL: http://games.jmir.org/2014/1/e3/
doi:10.2196/games.3183
PMID:25659116

Original Paper

A Functional Magnetic Resonance Imaging Assessment of Small Animals' Phobia Using Virtual Reality as a Stimulus

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Abstract

Background: To date, still images or videos of real animals have been used in functional magnetic resonance imaging protocols to evaluate the brain activations associated with small animals' phobia.

Objective: The objective of our study was to evaluate the brain activations associated with small animals' phobia through the use of virtual environments. This context will have the added benefit of allowing the subject to move and interact with the environment, giving the subject the illusion of being there.

Methods: We have analyzed the brain activation in a group of phobic people while they navigated in a virtual environment that included the small animals that were the object of their phobia.

Results: We have found brain activation mainly in the left occipital inferior lobe (P<.05 corrected, cluster size=36), related to the enhanced visual attention to the phobic stimuli; and in the superior frontal gyrus (P<.005 uncorrected, cluster size=13), which is an area that has been previously related to the feeling of self-awareness.

Conclusions: In our opinion, these results demonstrate that virtual stimulus can enhance brain activations consistent with previous studies with still images, but in an environment closer to the real situation the subject would face in their daily lives.

(JMIR Serious Games 2014;2(1):e6) doi:10.2196/games.2836

KEYWORDS

neuroimaging; patient assessment; virtual reality; phobia

Introduction

Small Animal Phobia

Phobias are one of the most wide spread and common disorders of modern life, affecting 1 in 10 people at some point of their lives [1-3]. More specifically, small animals' phobia is one of the most disabling ones, due to the possibility of facing the animal in daily life. In fact, 40% of specific phobias belong to the category of small animals, including bugs, mice, snakes, and bats [4].

Evaluating State of the Phobia

In order to evaluate the state and evolution of the phobia, many studies have been conducted using brain imaging techniques, such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), or electroencephalography (EEG). To date, most of those studies used photographs or videos of real animals as stimulus to provoke the reaction of the subject. For example, Paquette et al [5] used film excerpts of real spiders as stimulus, and excerpts of real butterflies as control. They aimed to probe the effects of cognitive behavioral therapy (CBT) on the neural correlates of spider phobia. They found significant activation of the right dorsolateral prefrontal cortex and the parahippocampal gyrus during the phobogenic stimulus before the CBT, which disappeared after it.

Regarding the studies that used pictures as stimulus, several of them analyzed the amygdala activation when comparing phobic and nonphobic subjects. For example, Schienle et al [6] studied the effects of a cognitive therapy, comparing pictures of real spiders with images that provoked fear, disgust, or images that were neutral. Another example is the study of Larson et al [7], who also used pictures as stimulus. Alpers et al [8] studied the amygdala activation and its relationship with attention over spider-phobic women, employing superimposed images of spiders and birds during the task. Apart from the amygdala, several studies that used pictures as stimuli were focused on other brain areas, such as the insula. Straube et al [9] analyzed insula activation due to the anticipatory anxiety, which refers to the fear you feel when you are expecting to find the animal object of your phobia. In another study, Wendt et al [10] analyzed the relation of the insula activation to the defensive response the subject experiences before the appearance of their feared object, using sustained exposure to the phobia relevant stimuli. Regarding other neuroimaging techniques, Scharmüller et al [11] used EEG to investigate the symptoms of spider phobia, again using pictures as stimulus. They found sources of activation in areas related to the visuo-attentional processing, emotional processing, and representations of aversive bodily states.

Virtual Reality Benefits

In the field of phobias, virtual reality (VR) has been repeatedly used to treat the disorder, but to our knowledge, it has not been used for the assessment of the disturbance yet. VR is a technology that comprises computer-generated simulations of reality [12]. Among most common treatments for mental disorders are the cognitive behavioral treatments, based on the exposure of the subject to the object of their fear, to make them adapt progressively to the stimulus [13,14]. However, these direct-exposing techniques sometimes are considered “dangerous and ethically reprehensible” [14-16] because of the impact that the direct exposure can have on the subject. In this sense, VR allows exposure of the subject to the feared stimuli in a controlled environment that is considered safer and more ethically acceptable [17]. Botella et al [18] gave a list of the advantages that VR has in psychotherapy; from which we can emphasize the aforementioned allowance of running the therapy in a protected environment close to reality, where the patient can act without feeling threatened (from a “safe base”). Furthermore, in VR the patient can interact with the context, and the psychotherapist can grade the situation according to the patient’s state. Moreover, in a more technical way, VR is an excellent source of information in performance achievements, and allows for an accurate control of the situation. Finally, we can mention the ecological validity of the stimuli presentation.

One of VR’s many advantages is that it allows the patient to interact with the phobic object or situation as if they are real and they exist there with the feared animals. This concept is known as presence, the sense of being there, inside the virtual environment, although your body is physically located elsewhere [19-22].

The VR exposure therapy has been widely used in the treatment of specific phobias [23], such as acrophobia [24], claustrophobia [25], arachnophobia [26], hodophobia [27], and pteromerhanophobia [28]. An example of this kind of treatment in our field of interest (small animals phobia) is the one developed by Garcia-Palacios et al [29], using VR with spider phobic subjects. In another study, Botella et al [30] applied augmented reality, a VR-related technology, for treating cockroach phobic subjects. However, to date, VR has not been used inside the fMRI scanner as a stimulus to assess the responses of the phobic subjects in the presence of the feared elements.

Our proposal is that the use of VR as a stimulus inside an fMRI setting will entail the same advantages to the phobia evaluation that it brought to the phobia treatment. Traditionally, the phobia evaluation has been made using behavioral assessments and self-reported scales. Finding the neural correlates related to the phobia activation in each individual subject could help in their evaluation process, grading their level of phobia, and giving further information about their state. This knowledge can help the therapists to decide the most appropriate treatment for each particular patient, taking into account the brain activations that can be observed. Besides, the analysis of the brain activations related to the phobia once the treatment has finished can be used to evaluate if the treatment has been successful. Using VR inside an fMRI setting will allow the psychologists to place the patients in virtual situations related to the object of their phobia, where they are able to interact. It can also make the user feel present in the environment, creating a more “realistic” experience than the one induced by the visualization of videos or photographs. Consequently, we expect the activated brain areas to be more similar to those activated during the real experience. Furthermore, the experimenter will have the possibility of controlling the exposure to the virtual situations in the most convenient way, customizing it according to the patient’s situation, if it is required. Finally, this kind of system allows an easy monitoring of the behavioral responses of the participants inside the virtual environment.

In order to validate this proposal, our target in the present work is to examine whether VR can be used for the assessment of the phobia, provoking a more realistic and immersive situation than the view of a still photograph, which can be manipulated by the psychologist. We have used virtual environments where the subject can navigate freely, which should induce a higher sense of presence due to the self-control of the navigation route [31].

As presented previously in Clemente et al [32], our main hypothesis is that the brain areas activated with these environments will be coherent with the results from previous studies based on pictures or videos of real animals (see Multimedia Appendix 1).

Methods

Recruitment

For this study, we recruited 11 right-handed phobic women, between 20 and 35 years old (mean age 24.64). None of them had any other medical or psychological disorders, apart from the phobia. The participants' hand dominance was tested using the Edinburgh Handedness Inventory [33].

Expert clinicians who were also the therapists for the participants carried out the diagnosis and assessment phases. In order to be included in the study, the following inclusion criteria were considered: (1) meeting Diagnostic and Statistical Manual of Mental Disorders - 4th edition (DSM-IV) [1] criteria for specific phobia animal type, specifically cockroach and spider phobia; (2) having scores over 4 in phobic avoidance (on a scale of 0 to 8); (3) having no current alcohol or drug dependency; (4) having no diagnosis of major depression or psychosis; (5) not having been or being treated with a similar program; and (6) having a minimum of 1 year of duration for the problem. The Anxiety Disorders Interview Schedule [34] specific phobia section was used to carry out the differential diagnosis of the anxiety disorders included in the DSM.

These women were students, were paid for their participation in the study, and were recruited from the Universitat Jaume I in Castellón. Ethical approval was obtained from the authors' institution, and each subject signed a written informed consent prior to participation.

Environments

The virtual environments used during the task were programmed using GameStudio software (Conitec Datensysteme GmbH), which allowed us to develop three-dimensional objects and virtual worlds with which participants could interact and navigate. For this study, we have divided the task into three experimental conditions, all of them involving a room where the subject can navigate freely. In the first of these conditions "CLEAN", the patient navigates through a common clean bedroom (with a bed, a closet, and a desk with some books on it). In the second condition "DIRTY", the navigation is performed through the same room, but this time dirty and darker, giving the subject the feeling that the feared animal could appear in any moment; this room intends to stimulate the anxiety in the user. In the last condition "PHOBIC", the subject navigates through the same dirty room, but this time there appeared spiders and cockroaches. Each of these experimental conditions lasted 20 seconds. Figure 1 shows the captures of each environment.

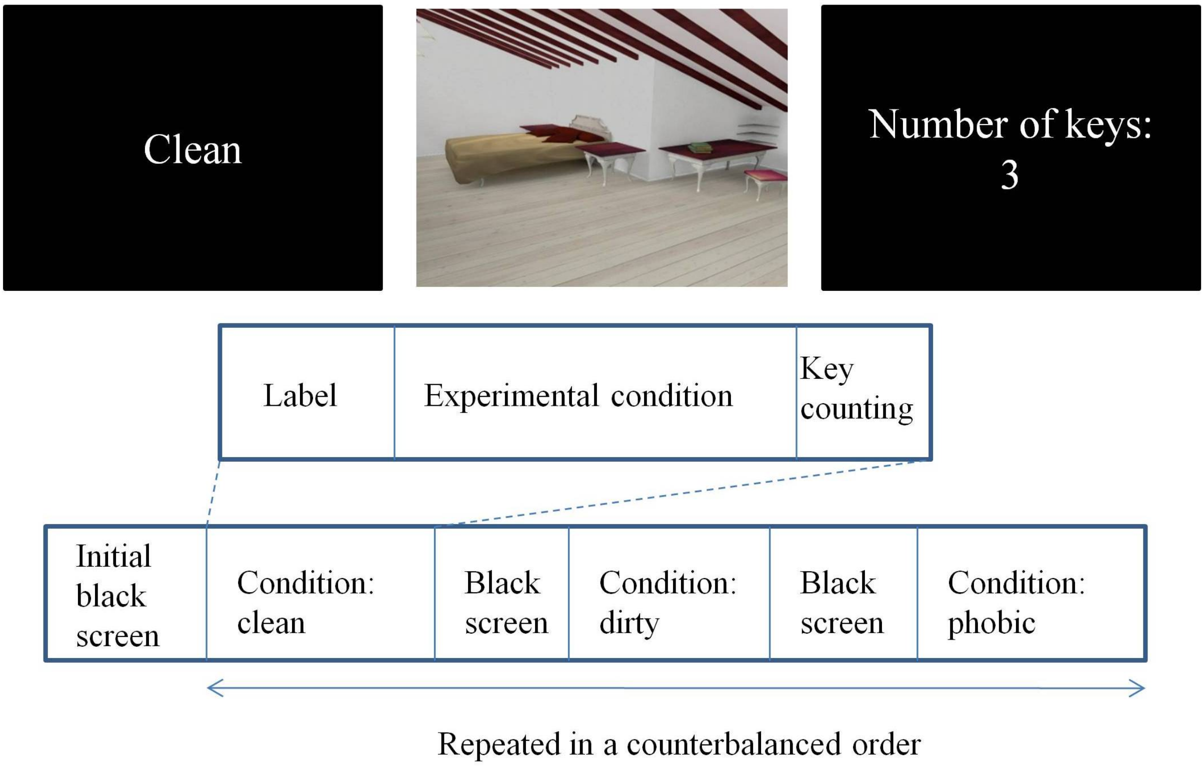
To prevent the subjects from staying still in the VR during the navigation periods, a search task was included in order to force them to move through the environment and confront the phobic stimulus in the correspondent experimental condition. This task consisted of searching and counting the number of red keys that appeared and disappeared in the environment. However, they were not encouraged to find them all, or to find them as quickly as possible, they were only told to continue searching for them during each period. After each task, the subjects were questioned about the number of keys that they had found (they had to answer in a short period of 4 seconds). While they were conducting the tasks, the researcher checked in the computer to see that they had answered properly. The number of keys that they counted was not relevant; it was just included to avoid the subjects remaining still during the experimental conditions.

A black screen was included between phases to give the subjects a rest period, during which brain activation could decay to its baseline values (6 seconds). After this, the label indicating the next task appeared (2 seconds). The total time between tasks was 12 seconds. Each of the three experimental conditions was repeated six times in a counterbalanced order to prevent effects produced by the order in which they were presented. At the beginning of the experiment there were 14 seconds of black screen to compensate for relaxation time (T1) saturation effects. The total time of the complete experiment was 9 minutes and 40 seconds. Figure 2 shows a scheme of the protocol.

Before entering the scanner, the subjects underwent a short training session where they were introduced to the VR navigation task. This training session was conducted in a supplementary virtual environment, without any kind of phobic stimuli, to avoid habituation. During the fMRI scan, the VR application checked the total time that they spent moving the joystick in each condition to guarantee that they did not remain still during the phobic stimulation.

Figure 1. Captures of the three environments used in the conditions: CLEAN (left), DIRTY (center), and PHOBIC (right).

Figure 2. Scheme of the protocol for the functional magnetic resonance imaging (fMRI) task.



Functional Magnetic Resonance Imaging Procedures

All the subjects were scanned in a 1.5 Tesla Siemens Avanto Magnetic Resonance scanning device. We used an adapted magnetic resonance (MR) helmet to prevent head movement. To display the environments, we used magnetic resonance imaging (MRI)-compatible video goggles, VisualStim Digital (Resonance Technology Inc), and for the navigation we used an adapted joystick (Resonance Technology Inc). First, sagittal T1-weighted structural images were acquired (224 x 256 matrix covering the brain with 176 contiguous 1 mm slices, repetition time [TR] = 11 ms, echo time [TE] = 4.94 ms, flip angle [FA] = 15 , voxel size = 1.04 x 1.04 mm). Then, the functional scanning was launched, synchronized with the virtual environments. Functional images were obtained using a relaxation time (T2*) single-shot echo-planar imaging sequence. We used 30 contiguous 4.2 mm interleaved axial slices—parallel to the anterior commissure – posterior commissure line (AC-PC line)—covering the entire volume of the brain with a 64 x 64 matrix (TR = 2000 ms, TE = 30 ms, FA = 90 , voxel size = 3.5 x 3.5 mm).

Data Analysis

We have used the statistical parametric mapping software (SPM8, Wellcome Department of Imaging Neuroscience) for the analysis of the fMRI data, launched with the 7.1 version of Matlab (MathWorks). We excluded the first 7 scans from the analysis to eliminate the decay of the fMRI signal that is associated with the moment when magnetization reaches equilibrium. First we aligned the images to the AC-PC line. Once it was done, we began the preprocessing of the data, realigning the functional images (estimate and reslice option), coregistering them to the structural images, and segmenting this latter anatomical scan. We then normalized the resliced functional volumes with the normalization parameters that we extracted after segmentation and normalization of the anatomical volumes for each subject separately (the template was provided by the Montreal Neurological Institute, MNI). None of the volunteers had to be excluded due to movements or distortions during the fMRI. Finally, we smoothed the images using a Gaussian kernel (full width at half maximum, FWHM, of 8 x 8 x 8 mm).

In a first fixed-effect level analysis, the functional time series for each subject and for each condition were modeled with a boxcar function convolved with the hemodynamic response function. The parameters for the motion correction were employed as regressors of noninterest. To eliminate the low frequency components in the signal caused by the scanner motion and warming, we applied a 96 seconds high pass filter.

We performed group tests at a second level random effect analysis. We tested for task related activation by performing a one-sample *t* test, including contrast images of estimated parameters for the differences of interest between conditions. As we have aforementioned, our fMRI paradigm was divided into three different navigation tasks (clean room, dirty room, and phobic-stimulus room) that we wanted to compare in order to obtain the contrasting brain activations. Although the results for the three contrasts have been obtained, the results that show the brain activations for the phobic stimulus are contained in the “phobic>clean” contrast. The “phobic>dirty” contrast shows phobic activations avoiding the anxiety feeling caused by the dirtiness of the room, and the “dirty>clean” contrast contains the anxiety related activations.

All contrasts at group level were considered if more than 10 adjacent voxels passed the statistical threshold of *P*<.005 (uncorrected). These results were corrected at *P*<.05 using AlphaSim correction (combined height threshold *P*<.005, and a minimum cluster size= 25) [35]. We used the xjView software utility for statistical parametric mapping (SPM) which uses the MNI coordinates system to obtain the specific brain areas that were activated for each contrast.

Results

We selected the contrast "phobic>clean", and looked for the main activated brain regions. We found activations in the left occipital inferior lobe and middle occipital gyrus bilaterally, among others (see "superior" part of Table 1, and Figure 3 also shows this activation). Brain regions that also displayed significant activations during the task were: (1) the cuneus bilaterally, (2) the superior frontal gyrus, and (3) the precuneus. In the middle part of Table 1 (also shown in Figure 4), we can observe the results obtained for the "phobic>dirty" contrast (inferior occipital lobe bilaterally, and the left superior, and middle frontal lobe); and in the lower part of Table 1 (also shown in Figure 5) are the results for the "dirty>clean" contrast (left superior occipital lobe, and right middle frontal gyrus, middle occipital gyrus and cingulate). In the table, apart from the anatomical area and brain hemisphere, the values for the location and T score of the maximum for each area, the size of the cluster activated in each area, and the *P* value used as threshold are shown.

Table 1. Brain area activation results.

Contrast	Anatomical region	Hemisphere	(x, y, z)	t_{10}	Cluster size	*P*
"Phobic>clean"	Occipital inferior lobe	L[a]	(-22, 98, -12)	4,19	36	<.05 corrected
	Middle occipital gyrus (BA19[c])	L[a]	(-54,-77, -4)	5,21	29	<.05 corrected
	Middle occipital gyrus	R[b]	(31, 77, 0)	4,76	175	<.05 corrected
	Cuneus	R[b]	(20, -91, 9)	4,01	36	<.05 corrected
	BA18[c]	R[b]	(26, -96, 6)	-11,64	28	<.05 corrected
	Cuneus	L[a]	(-8, -95, 30)	5,82	55	<.05 corrected
	Superior frontal gyrus	R[b]	(20, 49, 42)	4,52	13	<.005 uncorrected
	Precuneus	L[a]	(-1, -46, 68)	4,59	31	<.05 corrected
"Phobic>dirty"	Inferior occipital lobe	L[a]	(-26, -98, -12)	5,52	54	<.05 corrected
	Inferior occipital lobe	R[b]	(48, -84, -8)	4,43	22	<.005 uncorrected
	Superior frontal lobe	L[a]	(-22, 56, 34)	4,51	18	<.005 uncorrected
	Middle frontal lobe	L[a]	(-26, 14, 63)	5,25	18	<.005 uncorrected
"Dirty>clean"	Superior occipital lobe	L[a]	(-15, -91, 30)	5,69	201	<.05 corrected
	Middle frontal gyrus	R[b]	(24, 53, -8)	5,23	39	<.05 corrected
	Middle occipital gyrus	R[b]	(27, -84, 13)	6,81	184	<.05 corrected
	Cingulate gyrus	R[b]	(17, -35, 30)	7,40	14	<.005 uncorrected

[a]L=left
[b]R=right
[c]BA = Brodmann area

Figure 3. Brain activations for the “phobic>clean” contrast.

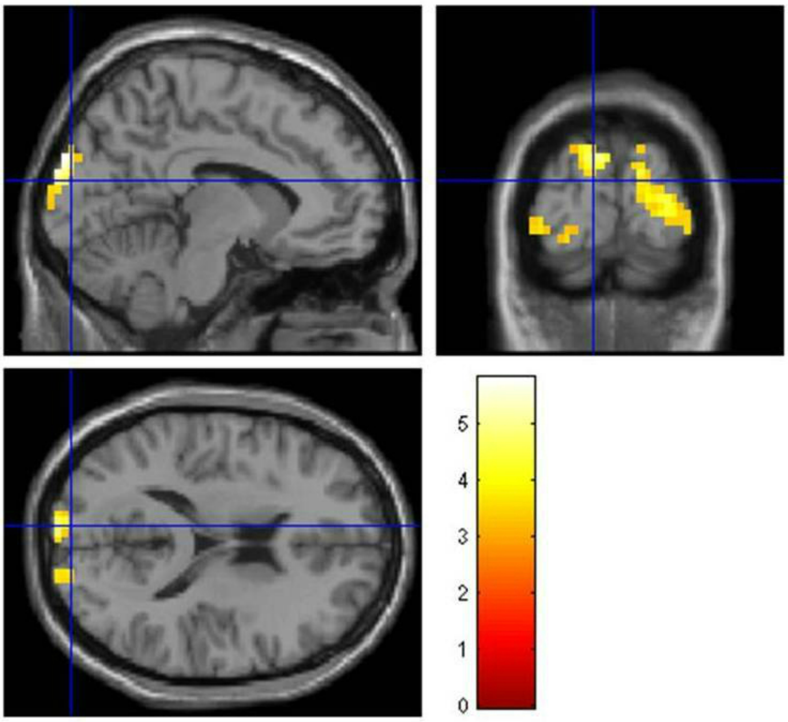


Figure 4. Brain activations for the “phobic>dirty” contrast.

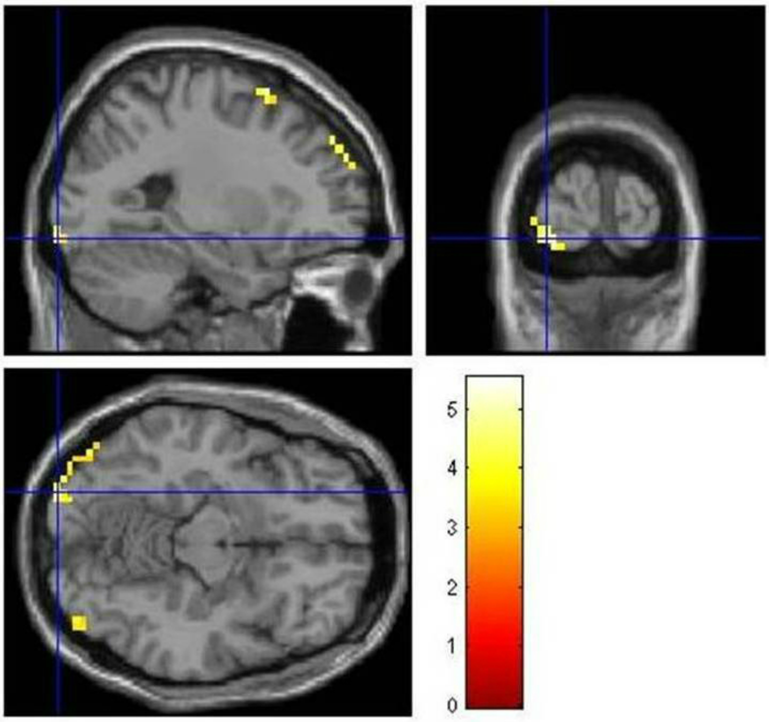
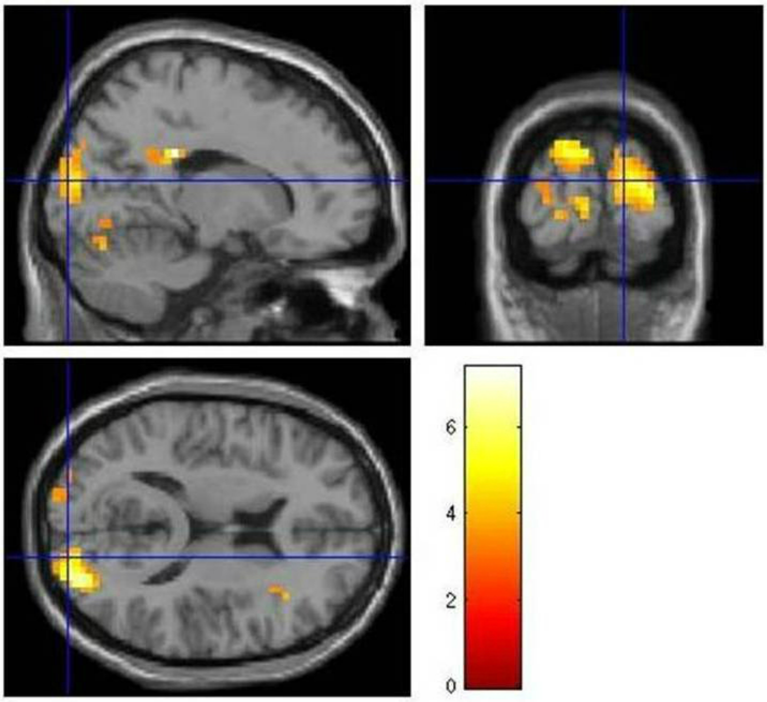


Figure 5. Brain activations for the “dirty>clean” contrast.



Discussion

Main Goal

The main goal of our study was to analyze the brain areas activated due to phobic stimulus during a subject’s navigation in a virtual environment through the three experimental conditions previously described (CLEAN, DIRTY, and PHOBIC). The main results, for the purposes of the study, are those obtained when comparing the brain activations between the phobic and the clean conditions (“phobic>clean”), which reflect the fear and anxiety felt by the subjects due to the phobic stimulus when compared with an emotionally neutral situation. Both the phobic and dirty situations may generate anxiety in the participant. However, in the dirty condition, the anxiety is generated by the fact of being in a threatening room (because of the dirtiness of the room, the participant may feel that is a dangerous place to be), and in the phobic condition, apart from the dirtiness of the room there are phobic stimuli. Our hypothesis is that in the “phobic>clean” comparison, the activations may be caused by both factors, while in the “phobic>dirty” contrast, the activations would be related to the phobia itself, and not to the anxiety feeling.

In the following paragraphs, we will comment on the results of the “phobic>clean” contrast in comparison with the results obtained in other studies about phobia. After that, we will discuss briefly the results obtained in the other two contrasts, “phobic>dirty” and “dirty>clean”. Finally, the limitations of the study will be commented on, and we will make some overall conclusions.

Principal Results

One of the most important activated areas in the “phobic>clean” contrast is the occipital lobe, more specifically, the left inferior area and in the middle lobe bilaterally. Another important result was the activation obtained in the superior frontal gyrus. Finally, activations were also found in the cuneus and precuneus. A more detailed explanation of the importance of these results is found below.

The Occipital Lobe

The occipital lobe mainly controls the visual areas, which are necessary for the performance of a navigation task. In the inferior area of the occipital lobe, we found activation in the lingual gyrus, which is believed to play a role in dreaming as well as in vision, especially in the recognition of words [36]. In this area, we also found activation in the Brodmann area 18, part of the extrastriate visual cortex. This encompasses multiple functional areas, including V3, V4, V5/MT, which are sensitive to motion, or the extrastriate body area used in the perception of human bodies [37,38].

Paquette et al had already found brain activation in the occipital lobe area [5] in a similar study carried out using film excerpts of spiders as the phobic stimulus, and film excerpts of butterflies as the neutral condition. They concluded that this activation was related to enhanced visual attention to the phobic stimuli, and that it supported vigilance functions in anxiety [39,40]. Moreover, those results were consistent with those obtained in other similar studies [41-43]. More recently, there have been several fMRI [6,8,9] and PET [11] studies among phobic and nonphobic subjects that have also found activation in the visual cortex. In fact, Straube et al [9] justified it as likely to be caused by the attention subjects put on the visual input that reflect an "increase in the processing of the cue, but also the expectation of behaviorally relevant sensory input". Moreover, several studies have pointed out the spread over time that the amygdala activation has to the occipital areas, due to the emotional relevance of the stimulus [44,45].

The Superior Frontal Gyrus

The other important activation in our results was found in the superior frontal gyrus. This area has been previously related to the feeling of self-awareness [46], which is increased when the phobic subjects watch the animal that provokes their fear. During the resting condition (CLEAN), the subjects are involved in a highly demanding sensory task during which they relax and are less conscious of themselves [46]. However, when the environment changes, and the phobic subjects find themselves in a fearful situation, their alert state increases, trying to inhibit their reaction in front of the phobic stimulus [5]. The natural reply to this stimulus is to avoid the fear response it provokes over them, and to do so they control their mind and body, increasing the consciousness they have of themselves. Also according to Du Boisgueheneuc et al [47], the superior frontal gyrus is related to the higher cognitive functions and the working memory.

However, there are some other studies that relate the visualization of a phobic stimulus to the deactivation of the frontal areas, especially of the prefrontal and orbitofrontal cortices [48,49]. They argue that visually elicited phobic reactions deactivate the areas related to cognitive control over emotions, resulting in motor readiness to fight or flight [49]. Nevertheless, those deactivations are related to more anterior areas of the brain, not involving the superior frontal gyrus. Moreover, in our study the subjects were mild phobics, so they were able to react in front of a phobic stimulus without needing to engage more instinctive reactions.

Although Paquette et al [5] did not find activation in the superior frontal gyrus, they discussed its relation to the voluntary self-regulation of emotion. More exactly, they exposed the results obtained in a PET study carried out by Johanson et al [50], where an increase in the frontal regional cerebral blood flow was obtained which correlated with the use of cognitive strategies to cope with the phobic situation. Paquette et al [5] pointed out that the phobic subjects activated their prefrontal areas when attempting to control their fear before the film excerpts of spiders. Goldberg et al [46] analyzed the subjective awareness feeling, and its relation with the frontal areas of the brain. They remarked how when watching an absorbing movie or being involved in a highly demanding sensory task (as in our case the virtual navigation through an immersive environment), the strong subjective feeling is of "losing the self", or as they explained, of disengaging from self-related reflective processes. Accepting this state, the increase in the self-awareness feeling during the visualization of phobic stimulus in a highly demanding navigation task is clearly related to the higher feeling of yourself when "fighting" the fear. In the words of Scharmüller et al [11], increased activation in the superior frontal cortex might reflect the patients' urge to flee during the confrontation with the feared object; and this link between the sensorimotor system and the effective/cognitive function is in line with the theory about embodied cognition [51]. In conclusion, we can consider this activation essentially related to the phobia.

The Cuneus and the Precuneus

With respect to our other results, we also found activity in the cuneus and the precuneus. Regarding the cuneus, it has been related to visual processing, which is directly associated with the sense of presence that the subject feels while navigating through a virtual environment [52]. On the other side, the precuneus has been related to self-consciousness, such as reflective self-awareness, that involves rating your own personality traits [53,54]. This information continues with the idea of an increase in the consciousness of yourself while you are exposed to a phobic stimulus, trying to reduce your reaction before it. It has also been involved in directing attention in space when planning or performing a movement [55,56], which is directly related to the navigation through a virtual environment.

The Amygdala

Although one of the areas most commonly related to phobias is the amygdala, it is not activated in our results. Several previous studies have been conducted to find the pattern of activation of this area [5,7,8], they have concluded that the amygdala suffers habituation over time [7]. This means that it is activated for a brief time period and then disappears. Paquette et al [5] also pointed out that this suggests that the amygdala may not be related to the phobic expression or experience, but to the fear conditioning [5,57]. Straube et al [9] also discussed that the amygdala activation may occur during brief presentations of the phobogenic stimuli, and in the induction of rapid behavioral responses, more than in the sustained and explicit processing of the threatening stimuli. Alpers et al [8] also pointed out that their activation in the amygdala was helped by the brief stimulus they used (200 ms). In our case, the use of periods of navigation as stimulus instead of pictures may be the cause of not detecting activation in this area (we used a block design for the protocol instead of an event-related). In fact, most of the studies around the amygdala have reported its activation during the very early stages of the stimulus [6-8].

The "Phobic>Dirty" Contrast

Having exposed the main results for the "phobic>clean" contrast, we will briefly discuss the results for the remaining contrasts. Regarding the "phobic>dirty" comparison, we found that the inferior occipital lobe played a major role in the fear response to the phobic stimulus, bilaterally. This is in concordance with the results obtained for the "phobic>clean" contrast, where we pointed out the relation of this area with the phobic response. As we have already said, the occipital lobe has been related to enhanced visual attention to the phobic stimuli [39,40]. The other important activation was located in the superior and middle frontal lobe, the result also contained in our previous contrast, due to its relation to the feeling of self-awareness and the action of the sensory system [46]. As we can see, the main results that we pointed out as being related to the phobia are still activated when we restrict the conditions of the contrast to avoid the anxiety results.

The “Dirty>Clean” Contrast

Regarding the “dirty>clean” contrast, the self-awareness was still high due to the greater fear of finding a spider or a cockroach when navigating through a dark and dirty environment than when navigating through a clean one, which resulted in the activation of the middle frontal gyrus. The activation of the occipital lobe was maintained here due to the higher visual processing when expecting the appearance of a feared animal. The last activation was located in the cingulate gyrus, which Paquette et al [5] pointed out to be mainly associated with the cognitive/internal generation of the emotional state by evoking visual imagery or memories. As we aforementioned, the activations in this contrast are due to the evocation of the fear, not to the exposition to it; so the meaning of the activation in the cingulate gyrus is clear as a generator of the emotional evocations.

Limitations

To finish this discussion, we will address some of the limitations that our study presents. First of all, it was conducted using a specific group of participants, namely, 11 right-handed women. This constitutes a small sample size, which restricts the statistical power of the study to detect changes in the blood-oxygen-level-dependent signal. All of the subjects were right-handed in order to prevent noise effects due to manual lateralization on brain activation in the virtual/spatial processing. Moreover, we chose all women in order to reduce the variability generated by gender differences. In fact, some previous studies have pointed out the importance of choosing only women, due to their higher activation in the presence of the emotional stimuli. Canli et al [58] indicated that they chose women because “they report more intense emotional experiences, and show more physiological reactivity in concordance with valence judgments than men”. Most of the studies we have aforementioned have been conducted with female subjects [5,6,9,11]. Scharmüller et al [11] pointed out that they restricted their study to use only female subjects since the prevalence of spider phobia is higher in them. Moreover, Schienle et al [6] remarked that most of the spiders’ phobia sufferers were females. Another limitation could be the absence of control subjects to compare with, which could constitute a future extension of the current work.

Conclusions

In conclusion, the results that we have obtained with VR is similar to the results obtained using real stimuli, in terms of fMRI brain activations. In fact, the main activations we found in the occipital and frontal areas are consistent with those found in previous studies that were conducted with spider phobic subjects using pictures or videos of real animals as stimuli. Moreover, the activation in the cuneus could be related to the sense of presence elicited in the subjects because of the navigation through the virtual environment. This finding opens the door to deeper investigations into the phobias, due to the fact that VR allows the recreation of normal life scenes in a more realistic and interactive way, that are impossible to achieve with other techniques. This kind of situation could allow, for example, the study of subjects with a mild phobia, whose fear cannot be excited by only the use of photographs.

Once the validity of the use of VR as a stimulus for evoking the phobia is evaluated, the next step will be to prove the usefulness of VR during the assessment of the brain activations after the subjects have passed through a psychological treatment to cure the disorder. This will be evaluated in future studies.

Acknowledgments

This study was funded by Vicerrectorado de Investigación de la Universitat Politècnica de València, Spain, PAID-06-2011, RN 1984; by the Ministerio de Educación y Ciencia Spain, Project Game Teen (TIN2010-20187); and partially by projects Consolider-C (SEJ2006-14301/PSIC), “CIBER of Physiopathology of Obesity and Nutrition, an initiative of ISCIII”, the Excellence Research Program PROMETEO (Generalitat Valenciana. Conselleria de Educación, 2008-157), and the Consolider INGENIO program (CSD2007-00012). Generalitat Valenciana, under a VALi+d Grant, supported the work of MC.

Conflicts of Interest

None declared.

Multimedia Appendix 1

PowerPoint of the presentation done during the REHAB 2013 Workshop, held in Venice (Italy) on the 5th of May 2013.

[PPT File (Microsoft PowerPoint Presentation), 5MB - games_v2i1e6_app1.ppt]

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Abbreviations

AC-PC line: anterior commissure – posterior commissure line
CBT: cognitive behavioral therapy
DSM: Diagnostic and Statistical Manual of Mental Disorders
DSM-IV: Diagnostic and Statistical Manual of Mental Disorders - 4th edition
EEG: electroencephalography
FA: flip angle
fMRI: functional magnetic resonance imaging
FWHM: full width at half maximum
MNI: Montreal Neurological Institute
MR: magnetic resonance
MRI: magnetic resonance imaging
PET: positron emission tomography
SPM: statistical parametric mapping
SPM8: statistical parametric mapping software version 8
T1: relaxation time
T2*: relaxation time
TE: echo time
TR: repetition time
VR: virtual reality

Edited by B Lange, G Eysenbach; submitted 19.07.13; peer-reviewed by A Moukheiber, T Agren; comments to author 12.02.14; revised version received 07.03.14; accepted 27.04.14; published 27.06.14.

Please cite as:
Clemente M, Rey B, Rodriguez-Pujadas A, Breton-Lopez J, Barros-Loscertales A, Baños RM, Botella C, Alcañiz M, Avila C
A Functional Magnetic Resonance Imaging Assessment of Small Animals' Phobia Using Virtual Reality as a Stimulus
JMIR Serious Games 2014;2(1):e6
URL: http://games.jmir.org/2014/1/e6/
doi:10.2196/games.2836
PMID:25654753

Original Paper

Personal, Social, and Game-Related Correlates of Active and Non-Active Gaming Among Dutch Gaming Adolescents: Survey-Based Multivariable, Multilevel Logistic Regression Analyses

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Abstract

Background: Playing video games contributes substantially to sedentary behavior in youth. A new generation of video games—active games—seems to be a promising alternative to sedentary games to promote physical activity and reduce sedentary behavior. At this time, little is known about correlates of active and non-active gaming among adolescents.

Objective: The objective of this study was to examine potential personal, social, and game-related correlates of both active and non-active gaming in adolescents.

Methods: A survey assessing game behavior and potential personal, social, and game-related correlates was conducted among adolescents (12-16 years, N=353) recruited via schools. Multivariable, multilevel logistic regression analyses, adjusted for demographics (age, sex and educational level of adolescents), were conducted to examine personal, social, and game-related correlates of active gaming ≥1 hour per week (h/wk) and non-active gaming >7 h/wk.

Results: Active gaming ≥1 h/wk was significantly associated with a more positive attitude toward active gaming (OR 5.3, CI 2.4-11.8; *P*<.001), a less positive attitude toward non-active games (OR 0.30, CI 0.1-0.6; *P*=.002), a higher score on habit strength regarding gaming (OR 1.9, CI 1.2-3.2; *P*=.008) and having brothers/sisters (OR 6.7, CI 2.6-17.1; *P*<.001) and friends (OR 3.4, CI 1.4-8.4; *P*=.009) who spend more time on active gaming and a little bit lower score on game engagement (OR 0.95, CI 0.91-0.997; *P*=.04). Non-active gaming >7 h/wk was significantly associated with a more positive attitude toward non-active gaming (OR 2.6, CI 1.1-6.3; *P*=.035), a stronger habit regarding gaming (OR 3.0, CI 1.7-5.3; *P*<.001), having friends who spend more time on non-active gaming (OR 3.3, CI 1.46-7.53; *P*=.004), and a more positive image of a non-active gamer (OR 2, CI 1.07–3.75; *P*=.03).

Conclusions: Various factors were significantly associated with active gaming ≥1 h/wk and non-active gaming >7 h/wk. Active gaming is most strongly (negatively) associated with attitude with respect to non-active games, followed by observed active game behavior of brothers and sisters and attitude with respect to active gaming (positive associations). On the other hand, non-active gaming is most strongly associated with observed non-active game behavior of friends, habit strength regarding gaming and attitude toward non-active gaming (positive associations). Habit strength was a correlate of both active and non-active gaming, indicating that both types of gaming are habitual behaviors. Although these results should be interpreted with caution because of the limitations of the study, they do provide preliminary insights into potential correlates of active and non-active gaming that can be used for further research as well as preliminary direction for the development of effective intervention strategies for replacing non-active gaming by active gaming among adolescents.

(JMIR Serious Games 2014;2(1):e4) doi:10.2196/games.3092

KEYWORDS

video games; interactive games; active games; adolescent; sedentary lifestyle; physical activity; determinants

Introduction

The prevalence of overweight and obesity in Dutch youth has increased in recent decades [1]. Overweight and obesity represent major public health problems [2,3]. Promoting physical activity (PA) and reducing sedentary behaviors are important targets for the prevention of overweight in youth [4,5].

Playing video games contributes significantly and substantially to sedentary behavior in youth [6-8]. For example, in the Netherlands, 95% of adolescent boys and 85% of adolescent girls play video games for an average of 10 and 4 hours per week (h/wk), respectively [8]. Correlates of playing video games identified previously include gender, age, ethnic background, and parents’ educational level [6,7,9,10]. One of the most consistent findings in these studies is the difference between boys and girls: boys generally spend more time gaming than do girls [6,7-9]. With respect to age, US children aged 11-14 years appear to play more than 8- to 10-year-old children. Regarding ethnic background, Hispanic and African American youth (8-18 years old) spend more time playing video games than white youth [7]. Furthermore, a study among 10- to 11-year-old Flemish children and their parents [9] and a study among 4- to 18-year-old Dutch children and their parents [10] showed that compared to children of higher-educated parents, children of parents with low or medium education levels spend more time playing video games.

A new generation of video games—active games—seems a promising alternative to sedentary games in promoting PA and reducing sedentary behaviors in youth [11-13]. Active games require movement of the body, more than only fingers and hands (eg, Nintendo Wii, PlayStation Move) [14]. Several studies have shown that active games involve light to moderate intensity physical activity (2-6 metabolic equivalents) [11,15], and pilot studies suggest that active gaming is associated with more PA and less sedentary time [13,16]. A large 6-month study showed that playing active games was associated with lower body mass index in children [17]. Furthermore, a number of studies have shown that a substantial proportion of adolescents play active games [17-19]. In the Netherlands, 43% of adolescents indicated that they play active games [19]. In Canada, this percentage was 25% [18].

To our knowledge, little attention has been paid to the correlates and determinants of active gaming. O’Loughlin explored potential sociodemographic, lifestyle, psychosocial, weight-related, and mental health correlates in Canadian adolescents. They showed that active gamers were more likely to be female, play non-active video games, watch ≥2 hours of television per day, be concerned about weight and be nonsmokers compared to adolescents who did not play active games [18]. A Dutch study comparing regular active gamers (≥1 h/wk) with nonregular active gamers (<1 h/wk) showed that regular active gamers (≥1 h/wk) were slightly but significantly younger (13.5 vs 14.1 years old) but did not differ with respect to gender, education level (of adolescent and parent), ethnicity, or sedentary screen time (TV/DVD and computer time) [20].

In a previous study, we examined and compared demographic correlates of active gaming and non-active gaming simultaneously in Dutch adolescents [19]. Irrespective of age, adolescents attending a lower educational level of secondary school were more likely to play active games ≥1 h/wk than adolescents attending higher educational levels. For non-active gaming, gender and age were correlates, with boys and older adolescents being more likely to play non-active games >7 h/wk than girls or younger adolescents [19]. There are no generally accepted cutoff values for active and non-active gaming. Therefore we based the 1 h/wk cutoff value on calculations in adults (because child-specific ones were not available at that time) that demonstrated that excessive weight gain can be prevented if energy balance is affected by 70 kcal/wk [21]. This corresponds with 1 hour of active gaming [15]. Second, 1 h/wk seems feasible to incorporate into intervention programs. Studies show that gaming adolescents spent, on average, 4-10 h/wk playing non-active games [8,19]. Replacing all non-active game time does not seems realistic, but asking to replace 1 hour out of 4-10 hours seems doable. Furthermore, only 28% of the active gaming adolescents played for ≥1 h/wk, indicating there is still room for improvement [19]. For non-active gaming, we used 1 hour per day (7 h/wk) as the cutoff value because this represents half of the 2 hours of maximum total screen time recommended for adolescents [22] and is the same cutoff value used by Allahverdipour et al in their study on non-active gaming [23].

In summary, previous studies tended to focus on the prevalence and on demographic characteristics of (active) gamers and on either playing traditional non-active games or active games rather than both types of gaming simultaneously. The latter is necessary to examine differences in the correlates of active gaming and non-active gaming. Moreover, no attention has been paid to potential personal, social, or game-related correlates of playing both active and non-active games. More specifically, the focus has been on who is playing active and non-active games rather than on why adolescents may play these games. Understanding why people play active and non-active games could provide directions to future intervention strategies attempting to substitute active game play for non-active game play. Therefore, the current study focused on potential personal, social, and game-related correlates of active as well as non-active gaming.

The selection of potential correlates for the current study was based on the findings of a focus group study conducted with adolescents about active and non-active gaming, which showed image, ease of use, and playing with others are important factors in gaming for adolescents [14]. Furthermore, the correlates were based on theories that have been applied to sedentary behavior, physical activity, or specific types of gaming [24-26]; Theory of Planned Behavior (TPB; attitude, descriptive norm) [27], Self-Determination Theory (SDT; autonomous motivation, game engagement) [28], Technology Acceptance Model (TAM; ease of use, competence) [29], and Habit Theory (habit) [30]. This has necessarily led to an extensive set of potential correlates tested, which we found appropriate given the fact that this is a first exploratory study of such correlates. The results can and will be used for more targeted exploration of correlates and potential determinants in future research. The correlates were structured according to three categories. First, personal correlates were distinguished, which refer to individual psychological factors such as attitude toward playing active and non-active games, autonomous motivation for playing video games, self-perceived gaming competence, habit regarding playing video games, and attitude toward physical activity. Second, we distinguished factors that relate to the social aspects of gaming (eg, descriptive norm) and social images of active and non-active gamers, referring to these as social correlates. Third, and finally, factors that are related to the video games were assessed, namely, perceived ease of use of playing active and non-active games, game engagement, and number of active and non-active games in possession.

The current study aimed to (1) examine potential personal, social, and game-related correlates of active gaming (≥1 h/wk) in adolescents; (2) examine potential personal, social, and game-related correlates of non-active gaming (>7 h/wk) in adolescents; and (3) compare the correlates of active gaming (≥1 h/wk) with those of non-active gaming (>7 h/wk).

Methods

Design and Procedure

The current study makes use of data gathered in a larger prospective study on video games among adolescents and their parents (not published yet). The present study reports cross-sectional data from the first questionnaire completed by adolescents. The questionnaire was administered in the classroom under the supervision of the researcher and/or a teacher. On the day of the first survey, a researcher explained the goals and procedures of the study in the classroom. The researcher asked adolescents in a school class session whether they played video games (active and/or non-active games) at least once a week. Those who answered "yes" (further referred to as "gaming adolescents") and were willing to participate received the "gaming questionnaire", containing questions about gaming characteristics and demographics. The adolescents who did not play video games received a "nongamers questionnaire", consisting of questions about demographics. The adolescents received an information letter for their parents with a passive consent procedure indicating that parents could object to the study participation of their child. In such cases, the questionnaire of the corresponding child was destroyed. Among adolescents who completed the entire study, 2 MP3 players, 6 gift vouchers of €10 for video games, and 6 gift vouchers worth €25 for video games were raffled as an incentive.

Participants

The Dutch secondary school system consists of three levels of education: (1) pre-vocational, (2) higher continued education, and (3) pre-university. The participants were recruited from 5 secondary schools in the Netherlands, covering all educational levels, whereby a maximum of 4 classes per school were included. The aim was to establish a representative sample of enrolled schools covering a wide range of socioeconomic, ethnic, and geographic characteristics, as described in Simons et al [19]. Therefore, the approached schools varied with respect to location (urban/nonurban) and educational level. In total, 459 students from 18 classes were invited to participate. The current study focused on the gaming adolescents only, resulting in 357 (77.7%) eligible students. Three parents objected to their child's participation, and 1 student was dismissed from class because of misbehavior and not filling out the questionnaires seriously. The data from these students were therefore excluded, resulting in approved responses from 353 adolescents.

The Central Committee on Research Involving Human Subjects in the Netherlands provided an exemption for this study to seek formal approval from the Medical Ethics Committee.

Measures

Demographic Factors

Questions regarding birth date (for calculating age), gender, and educational level (pre-vocational, higher education, pre-university) were included in the questionnaire. Educational level was dichotomized into low level (pre-vocational) and high level (higher education and pre-university).

Outcome Measures

We focused on 2 outcome measures: (1) time spent active gaming, and (2) time spent non-active gaming. To assess time spent active and non-active gaming, questions about frequency and duration were formulated based on existing and validated questionnaires for adolescents [31,32] for school and weekend days separately. Adolescents could indicate duration by selecting 1 of 4 categories (<30 minutes, 30 to <60 minutes, 1-2 hours, and >2 hours). The terms active and non-active games were explained as follows: non-active games are games in which players only have to use their fingers or hands, and active games are games that require movement of the body, more than only fingers and hands (eg, Nintendo Wii, PlayStation Move, Microsoft Kinect).

Time spent active gaming was dichotomized into durations lasting <1 h/wk and ≥1 h/wk [19,20]. Because there is no general accepted cutoff value for active gaming, this cutoff value was based on calculations in adults demonstrating that excessive weight gain can be prevented if energy balance is affected by 70 kcal/wk [21]. Based on calculations of energy expenditure during active video game play [15], substituting sedentary activities with playing active games for 1 h/wk corresponds to an additional 70 kcal of energy expenditure each week and may thus prevent excessive weight gain [20]. Second, 1 h/wk seems feasible to incorporate into intervention programs as described in the introduction.

Time spent non-active gaming was dichotomized into durations lasting ≤7 h/wk and durations lasting >7 h/wk. There is no general accepted cutoff value for non-active gaming. We used 1 hour per day as the cutoff value because this represents half of the 2 hours of maximum total screen time recommended for adolescents [22] and is the same cutoff value used by Allahverdipour et al in their study on non-active gaming [23].

Attitude, descriptive norm, image, perceived ease of use, and number of games in possession were assessed with respect to active and non-active gaming separately. Autonomous motivation, self-perceived gaming competence, habit, and game engagement were assessed with respect to gaming in general.

Personal Correlates

Attitude Toward Playing Active/Non-Active Games

Attitude (based on TPB [27]) was assessed by asking respondents to evaluate playing active/non-active games on six 5-point bipolar scales, based on a manual for constructing questionnaires based on TPB [33] (eg, "I think playing active/non-active games is": "very stupid" [score of 1] to "very enjoyable" [score of 5]). The 6 items were combined into one construct by averaging the scores (attitude active gaming, Cronbach alpha=0.77; attitude non-active gaming, Cronbach alpha=0.73).

Autonomous Motivation for Playing Video Games

Type of motivation was deduced from the SDT [24,28] and assessed using a modified version of the Perceived Locus of Causality scale [34]. To prevent the questionnaire from becoming too lengthy, we used a modified version by selecting the 2 most relevant items with the highest factor loadings for each type of motivation [35]. Four types of motivation were assessed: (1) external regulation, (2) interjected regulation, (3) identified regulation, and (4) intrinsic regulation [34]. The respondents were asked to indicate on a 5-point scale (totally disagree [score of 1] to- totally agree [score of 5]) whether they agreed on statements starting with "I play video games …" for example, for interjected regulation, "because I want my friends to think that I am good in playing video games"; for identified regulation, "because I want to improve in playing video games"; and for intrinsic regulation, "because playing videogames is fun." The 10 items were combined into a Relative Autonomy Index (RAI) by weighting the external subscale −2, the interjected subscale −1, the identified subscale +1, and the intrinsic subscale +2. Amotivation was not considered in the formulation of the RAI [36]. The minimum score for the RAI is −30, and the maximum score is +30. Higher positive scores for the RAI indicate more autonomous motivation, whereas lower negative scores indicate less autonomous motivation.

Self-Perceived Gaming Competence

Perceived competence is based on SDT, which contends that competence is one of the basic needs that drive behavior [24]. Self-perceived gaming competence was measured using the 3 most relevant items of the validated Intrinsic Motivation Inventory (originally consisting of 6 items) [37]. Respondents had to indicate on a 5-point scale ([score of 1] totally disagree to [score of 5] totally agree) whether they agreed with the following statements: "I believe I am good at playing video games", "I think I am better at playing video games than other people my age and gender", and "I am generally happy with my gaming performance." The statements were combined into one construct (Cronbach alpha, 0.84). The Cronbach alpha in the current study was 0.84, which is comparable to the value of 0.81 that Markland and Hardy [38] observed for the competence subscale when they assessed the factorial and construct validity of the Intrinsic Motivation Inventory.

Habit Regarding Playing Video Games

To assess habit strength with respect to playing video games, we used 4 items from the 12-item Self-Reported Habit Index [30]. Four items that reflected 2 important aspects of habits were selected: automaticity (the extent to which particular behaviors are executed efficiently, outside control and awareness) and identity (the extent to which the behavior is part of everyday life and reflects a sense of personal style). The following items were included in the current study regarding playing video games ("Playing video games is something"): "…I do automatically" (automaticity), "…I start doing before I realize I'm doing it" (automaticity), "that is typically me" (identity), and "that belongs to my daily routine" (identity). Respondents were asked to indicate on a 5-point scale (totally disagree [score of 1] to totally agree [score of 5]) whether they agreed with the items. The reduced scale demonstrated good internal consistency in the current study (Cronbach alpha, 0.81).

Attitude Toward Physical Activity

Attitude toward physical activity was measured by asking respondents to evaluate physical activity on two 5-point bipolar scales, based on the manual for TBP questionnaires [33] ("Do you think it is fun or stupid to increase your physical activity behavior (very stupid [score of 1] to a lot of fun [score of 5])" and "Do you think it is good or bad to increase your physical activity behavior?" (very bad [score of 1] to very good [score of 5]). These 2 items were combined into one construct (Cronbach alpha, 0.76).

Social Correlates

Descriptive Norm Active and Non-Active Gaming

Descriptive norm (based on TPB [27]) was assessed on a scale from 1 (very little time) to 5 (very long time) with the following items, based on the TBP manual [33]: "Do most of your friends spend a lot of or little time playing active/non-active games?" and "Do your brothers or sisters spend a lot of or little time playing active/non-active games?" The items were dichotomized into low (score 1-3) and high descriptive norms (score 4-5) for brothers/sisters and friends separately.

Image Regarding Active Gamers and Non-Active Gamers

Image as a potential correlate for gaming arose from focus groups held with adolescents about active and non-active gaming [14]. Social image or prototype is also a construct belonging to the Prototype Willingness model [39] and denotes the image that an adolescent associates with a behavior or the perceptions of the type of person who performs the behavior [39]. The Prototype Willingness model was originally developed to explain health risk behaviors (eg, drinking and smoking) in adolescents and young adults, and studies have shown that the images adolescents hold of peers who engage in risk behaviors are associated with adolescents' willingness to engage in risk behaviors when the opportunity arises [40,41]. To the best of our knowledge, the Prototype Willingness model has not yet been applied to gaming behavior. To assess the image of active and non-active gamers, respondents were asked to indicate what they thought of "an active/non-active gamer" using 6 characteristics. Respondents had to indicate on a 5-point scale ([score of 1] totally disagree to [score of 5] totally agree) whether they agreed with the following statements: "I think an active/non-active gamer is (1) unsportsmanlike, (2) cool, (3) childish, (4) companionable, (5) boring, or (6) attractive. Negative characteristics (unsportsmanlike, childish, and boring) were reversed, and statements were then combined into one construct for active gamers (Cronbach alpha, 0.62) and one construct for non-active gamers (Cronbach alpha, 0.77).

Game-Related Correlates

Perceived Ease of Use of Playing Active/Non-Active Games

Perceived ease of use is a construct deduced from the TAM and measures the extent to which people believe playing active/non-active games is effortless. To assess the perceived ease of use of playing active and non-active games, 2 questions were asked for active and non-active games separately: (1) "It is easy for me to learn how active/non-active games work", and (2) "Playing active/non-active games is easy for me." Respondents had to indicate on a 5-point scale ([score of 1] totally disagree to [score of 5] totally agree) whether they agreed. The 2 items were derived from Hsu and Lu [29] and were based on a validated questionnaire developed by Davis [42]. The 2 items were combined into one construct for non-active games (Cronbach alpha, 0.78) and one for active games (Cronbach alpha, 0.88).

Game Engagement

Game engagement is a generic indicator of game involvement that consists of the categories absorption, flow, presence, and immersion. Engagement was measured by means of the Game Engagement Questionnaire (GEQ) [43], which was developed to measure the potential of an individual to become engaged in video games. The GEQ consists of 19 items (eg, "If I play video games, I lose track of time", "If I play video games, I do not hear if someone is talking to me", "If I play video games, the game feels real"). Respondents had to answer on a 3-point scale (no [score of 1], a little [score of 2], yes [score of 3]), and the scores were summed to yield a cumulative score. The Cronbach alpha in the current study was 0.91, which is comparable to the value of 0.85 observed by Brockmeyer et al when developing the scale [43].

Number of Active and Non-Active Games in Possession

Respondents were asked to indicate how many active and non-active games they had in their household.

Analyses

Of the 353 adolescents, 44 had missing values for one of the dependent variables (time spent active/non-active gaming), and another 59 adolescents had missing values for one of the potential correlates, resulting in 250 (80.9%) adolescents with complete data. We therefore decided to impute data using chained imputations [44] with an imputation model consisting of all the potential predictors, the dependent variables, and 6 other variables that we thought were related to missingness. These 6 variables were (1) spending a lot or a little time on playing active games (a little [score of 1] to a lot [score of 5]), (2) spending a lot or a little time on playing non-active games (a little [score of 1] to a lot [score of 5]), (3) playing active games in comparison with others (much less [score of 1] to much more [score of 5], (4) playing non-active games in comparison with others (much less [score of 1] to much more [score of 5]), (5) attitude toward spending more time on active gaming (scale 1-5), (6) attitude toward spending less time on non-active gaming (scale 1-5). Trace plots of means and standard deviations of imputed variables were checked for convergence. It was found that results were stable after 50 imputations, which was used in the final analyses.

Based on these 50 imputed databases, first descriptive analyses were performed on demographics to describe the study population and to explore personal, social, and game-related factors among gaming adolescents. Furthermore, to examine potential personal and game-related correlates of active ≥1 h/wk and non-active gaming >7 h/wk, 2 multilevel logistic regressions were performed, with all variables entered simultaneously. Variables entered in the model included all 17 potential correlates and the demographics (age, sex, and educational level of adolescents) that were observed to correlate with either active or non-active gaming [19]. We fitted multilevel models to correct for a potential clustering effect at the school and class levels. In the first multiple logistic regression, the dependent variable was active gaming for more or less than 1 h/wk. In the second multiple logistic regression, the dependent variable was non-active gaming for more or less than 7 h/wk. *P* values <.05 were considered to be statistically significant. The multiple imputations as well as all the analyses based on the imputed datasets were performed in STATA/SE 12.1. Finally, Spearman's correlation coefficients on the complete cases were calculated to provide insight into relations between active gaming ≥1 h/wk and non-active gaming >7 h/wk and their potential correlates. This was done in IBM SPSS Statistics version 20.

Results

Participants

The mean age of the total group of participants (n=353) was 13.9 years (SD1.5); the majority were male (60.6%; 214/353) and attended a high level of education (64.6%; 228/353). Of the 353 participants, 33.2% (117/353) played active games ≥1 h/wk, 33.2% (117/353) played non-active games >7 h/wk, and 9.9% (35/353) played both active games ≥1 h/wk and non-active games >7 h/wk.

Table 1 shows the descriptive statistics for the potential correlates for active (≥1 h/wk) and non-active gamers (>7 h/wk) separately. In general, participants had a positive attitude toward both active and non-active gaming and had friends who spent much time on non-active gaming. Furthermore, the participants had a positive attitude toward PA and thought the use of active and non-active games was easy.

Table 1. Means and standard deviations of potential correlates of active and non-active gaming (N=353).

Characteristic (scale)	Active gaming (h/wk)		Non-active gaming (h/wk)	
	Active gamers (≥1)	Active gamers (<1)	Non-active gamers (>7)	Non-active gamers (≤7)
Personal correlates, mean (SD) [a]				
Attitude toward playing active games (1-5)	3.5 (0.79)	3.1 (0.8)	3.1 (1.3)	3.3 (0.6)
Attitude toward playing non-active games (1-5)	3.3 (1.0)	3.4 (0.8)	3.8 (0.9)	3.2 (0.6)
Autonomous motivation for playing video games (−30 through +30)	3.8 (4.4)	4.1 (3.2)	4.5 (4.3)	3.7 (3.1)
Self-perceived gaming competence (1-5)	3.2 (1.8)	3.3 (1.2)	3.8 (1.6)	3.0 (1.1)
Habit regarding playing video games (1-5)	2.7 (1.9)	2.6 (1.2)	3.5 (4.3)	2.3 (1.0)
Attitude toward physical activity (1-5)	4.2 (1.4)	4.3 (0.9)	4.0 (1.3)	4.4 (0.8)
Social correlates				
Descriptive norm active gaming of … friends (% high score on descriptive norm scale)	21	7	10	13
Descriptive norm active gaming of … brothers/sisters (% high score on descriptive norm scale)	29	7	11	16
Descriptive norm non-active gaming of … friends (% high score on descriptive norm scale)	51	47	76	35
Descriptive norm non-active gaming of … brothers/sisters (% high score on descriptive norm scale)	31	34	32	33
Image regarding active gamers (1-5; mean, SD)	3.2 (0.9)	3.1 (0.7)	3.0 (1.0)	3.2 (0.6)
Image regarding non-active gamers (1-5; mean, SD)	3.3 (1.4)	3.4 (1.0)	3.8 (1.2)	3.2 (0.9)
Game-related correlates, mean (SD)				
Perceived ease of use of playing active games (1-5)	3.9 (1.9)	3.7 (1.3)	3.7 (2.1)	3.8 (1.2)
Perceived ease of use of playing non-active games (1-5)	4.1 (1.7)	4.1 (1.1)	4.3 (1.6)	4.0 (1.1)
Game engagement (19-57)	31.1 (16.8)	31.0 (10.8)	35.6 (15.7)	28.7 (9.9)
Number of active games in possession	12.1 (61.7)	3.2 (15.3)	9.2 (14.7)	4.7 (14.7)
Number of non-active games in possession	37.5 (116.7)	35.8 (68.6)	54.5 (118.5)	27.3 (66.2)

[a]Mean and SD are based on results from 50 imputation for the missing values.

Correlates of Active Gaming

Next, we evaluated which factors correlated with active (≥1 h/wk) and non-active gaming (>7 h/wk) in multivariable analyses. The regression analyses revealed the following statistically significant correlates for active gaming (≥1 h/wk; Table 2): Personal: “attitude toward active gaming”, “attitude toward non-active gaming”, and “habit regarding playing video games.” Social: “descriptive norm active gaming of friends”, and “descriptive norm active gaming of brothers/sisters.” Game-related: “game engagement.” Active gamers (≥1 h/wk) had a more positive attitude toward active gaming, a less positive attitude towards non-active gaming, a higher score on habit strength regarding gaming, had brothers/sisters and friends who spend more time on active gaming, and scored lower on game engagement.

Correlates of Non-Active Gaming

With respect to non-active gaming (>7 h/wk), the statistically significant correlates were Personal: "attitude toward non-active games" and "habit regarding playing video games." Social: "descriptive norm non-active gaming of friends", and "image regarding non-active gamers." None of the game-related correlates were significant. Non-active gamers (>7 h/wk) had a more positive attitude toward non-active games, had a higher score on habit strength regarding gaming, had friends who spend more time on non-active gaming, and a more positive image regarding non-active gamers.

Table 2. Logistic regression analyses of correlates of active ≥1 h/wk and non-active gaming >7 h/wk.

		Active gaming ≥1 h/wk[b]			Non-active gaming >7 h/wk[b]		
Correlate[a]		OR	95% CI	*P* value	OR	95% CI	*P* value
Personal							
	Attitude toward active gaming[c]	5.3	2.4-11.8	<.001	0.5	0.23-1.0	.052
	Attitude toward non-active gaming[c,d]	0.3	0.1-0.6	.002	2.6	1.1-6.3	.035
	Autonomous motivation for playing video games	1.0	0.8-1.1	.58	1.1	0.96-1.3	.14
	Self-perceived gaming competence	1.0	0.6-1.5	.88	0.84	0.51-1.37	.49
	Habit regarding gaming[c,d]	1.9	1.2-3.2	.008	3.0	1.7-5.3	<.001
	Attitude toward physical activity	0.9	0.5-1.5	.7	0.8	0.5-1.3	.35
Social							
	Descriptive norm active gaming: friends[c]	3.4	1.4-8.4	.0089	0.57	0.20-1.65	.30
	Descriptive norm active gaming: brothers/sisters[c]	6.7	2.6-17.1	<.001	0.54	0.17-1.74	.30
	Descriptive norm non-active gaming: friends[d]	1.3	0.6 -2.6	.55	3.3	1.46-7.53	.004
	Descriptive norm non-active gaming: brothers/sisters	0.7	0.3-1.3	.24	0.6	0.27-1.33	.21
	Image regarding active gamers	1.3	0.6-2.8	.58	0.51	0.21-1.23	.13
	Image regarding non-active gamers[d]	0.9	0.5-1.5	.6	2.0	1.07-3.75	.030
Game-related							
	Perceived ease of use of playing active games	1.2	0.8-1.7	.31	0.94	0.64-1.39	.75
	Perceived ease of use of playing non-active games	0.9	0.6-1.3	.49	1.24	0.78-1.96	.36
	Game engagement[c]	0.95	0.91-0.997	.04	1.02	0.97-1.08	.37
	Number of active games owned	1.03	0.99-1.07	.098	1.03	0.99-1.06	.13
	Number of non-active games owned	1.0	0.99-1.0	.78	1.0	0.99-1.0	.65

[a]Adjusted for demographics: gender, age, educational level.

[b]Values are shown based on results from 50 imputation for the missing values (N=353).

[c]Significant correlate for active gaming ≥1 h/wk.

[d]Significant correlate for non-active gaming >7 h/wk.

Bivariate Associations

Table 3 presents the bivariate correlations between the potential correlates and active (≥1 h/wk) and non-active gaming (>7 h/wk) based on the complete case sample (N=250). Active gaming (≥1 h/wk) was significantly, strongly, positively correlated (r≥0.5) with the number of active games owned; significantly, moderately, positively correlated (r=0.3) with attitude toward non-active gaming and descriptive norm active gaming brothers/sisters; and significantly, weakly, positively correlated (r=0.1) with descriptive norm active gaming friends, image regarding active gamers, and perceived ease of use of active games.

Non-active gaming (>7 h/wk) was significantly, strongly, positively correlated (r≥0.5) with attitude toward non-active gaming, habit, and image regarding non-active games and significantly moderately, positively correlated (r=0.3) with self-perceived gaming competence, descriptive norm non-active gaming friends, perceived ease of use of non-active gaming, game engagement, and number of non-active games owned. A significant, moderate, negative association was observed with attitude toward physical activity. The highest correlation coefficient among the correlates was 0.58, indicating that colinearity is not a problem.

Table 3. Spearman's correlations between active gaming ≥1 h/wk, non-active gaming >7 h/wk, and potential correlates based on the complete case sample (n=250).

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.Active gaming ≥1 h/wk	−.03	.34[c]	−.11	-.03	−.02	.04	−.01	.21[c]	.30[c]	.03	−.03	.17[b]	−.02	.18[b]	.003	−.01	.54[c]	.01
2.Non-active gaming >7 h/wk	–	−.09	.49[c]	.12	.41[c]	.58[c]	−.24[c]	−.04	−.07	.38[c]	−.02	−.06	.49[c]	−.02	.25[c]	.38[c]	−.07	.30[c]
3.Attitude towards active gaming		–	.06	.13[a]	.03	.05	.03	.10	.07	.06	.0	.36[c]	−.03	.27[c]	.11	.08	.42[c]	.07
4.Attitude toward non-active gaming			–	.26[c]	.50[c]	.53[c]	−.18[b]	.14[a]	−.12	.35[c]	.02	.05	.50[c]	.12	.38[c]	.39[c]	−.09	.37[c]
5.Autonomous motivation for playing video games				–	0.26[c]	.03	.06	.07	.07	.30[c]	.11	−.01	.16[a]	.11	.17[b]	.21[c]	.04	.12
6.Self-perceived gaming competence					–	.53[c]	−.13[a]	.03	.04	.34[c]	.0	−.0	.49[c]	.02	.37[c]	.40[c]	.0	.29[c]
7.Habit regarding gaming						–	-.22[c]	.02	−.10	.37[c]	.05	.03	.54[c]	−.06	.24[c]	.54[c]	−.03	.36[c]
8.Attitude toward physical activity							–	.05	.11	−.09	.08	.01	−.12	.01	−.04	−.21 [c]	.05	−.08
9.Descriptive norm active gaming friends								–	.17[b]	.15[a]	−.01	.14[a]	.05	.02	−.02	.09	.06	−.04
10.Descriptive norm active gaming brothers/sisters									–	−.06	.18[b]	−.01	−.07	.09	.10	.04	.32[c]	.08
11.Descriptive norm non-active gaming friends										–	.09	−.04	.37[c]	.02	.10	.30[c]	.05	.21[c]
12.Descriptive non-active gaming brothers/sisters											–	.03	−.02	.09	.02	.19[b]	.09	.08
13.Image regarding active gamers												–	.16[b]	.08	.04	.13[a]	.18[b]	.03
14.Image regarding non-active games													–	−.04	.25[c]	.37[c]	−.04	.39[c]
15.Ease of use active gaming														–	.42[c]	−.002	.16[a]	.10
16.Ease of use non-active gaming															–	.22[c]	.03	.27[c]
17.Game engagement																–	−.0	.28[c]
18.Number of active games owned																	–	.25[c]
19.Number of non-active games owned																		–

[a]Correlation is significant at the .05 level (2-tailed).

[b]Correlation is significant at the .01 level (2-tailed).

[c]Correlation is significant at the .001 level (2-tailed).

Discussion

Overview

The aim of the present study was to examine correlates of active gaming ≥1 h/wk and non-active gaming >7 h/wk and to compare these correlates, taking demographics such as gender, age, and educational level into account. A greater understanding of these correlates contributes to understanding why people play active and non-active games and provides insight into potential barriers of and opportunities for intervention strategies attempting to substitute active game play for non-active game play.

The findings of the present study show that significant correlates of active gaming ≥1 h/wk include the personal factors attitude toward active gaming, attitude toward non-active gaming, habit regarding gaming, the social factors descriptive norm active gaming of brothers/sisters and friends, and the game-related factor game engagement (first research aim). Significant correlates of non-active gaming >7 h/wk include the personal factors attitude toward non-active gaming and habit regarding gaming, and the social factor descriptive norm non-active gaming of friends and image of non-active gamers (second research aim). When comparing correlates of active gaming with non-active gaming, it shows that attitude toward non-active gaming (although the direction differs), habit strength, and descriptive norms (active or non-active gaming) of friends are the only factors associated with both types of gaming (third research aim).

Sole Correlates of Active Gaming

Important correlate of active gaming ≥1 h/wk included the social factor descriptive norm active gaming of brothers/sisters, in line with previous studies that showed that the social aspect was important for ongoing participation in playing active games [14,45,46]. Furthermore, observational real life studies showed that active games are often played with siblings [19,47]. Because descriptive norm active gaming of brothers and sisters was the most important correlate for active gaming ≥1 h/wk, we recommend that active game intervention strategies focus on families instead of individuals.

Game engagement was a weak correlate for active gaming. Active gamers were a bit less likely to be engaged during playing games. Game engagement was measured with the validated GEQ, a questionnaire to measure the potential of an individual to become engaged in video games [43]. However, based on this study, we do not know if it refers to a trait in the sense that some adolescents become more easily immersed when gaming or a state in the sense that some games have stronger immersive qualities (or a mix).

A commonly expressed concern about active games is that only youth who like physical activity and are already physically active (and therefore not a target group for health promotion interventions) will play active games. However, the findings of the current study do not support this concern because we found that attitude with respect to physical activity was unrelated to active game play ≥1 h/wk.

Sole Correlates of Non-Active Gaming

Image regarding non-active gamers was the only factor that solely correlated with non-active gaming. Adolescents playing non-active games >7 h/wk were more positive about the image of a non-active gamer. Image or prototype is a construct belonging to the Prototype Willingness model [39] and denotes the image that an adolescent associates with a behavior or the perceptions of the type of person who performs the behavior (in this case non-active gaming) [39]. The Prototype Willingness model has mainly been applied to risk behaviors such as drinking and smoking; to our knowledge, it has not been applied yet to gaming behavior. Image was mentioned as a factor during focus groups with adolescents about gaming, but only regarding active gaming [14,48]. Some New Zealand girls (10-12 years old) did not see themselves playing active games once they reached high school, because it could be embarrassing. They thought playing active games is less socially acceptable for older girls than for younger girls [48]. In focus groups with Dutch adolescents, it was mentioned that it was not “cool” to play active games on your own. However, in the current quantitative study, these findings were not confirmed, because image appeared only to be a correlate for non-active gaming and not for active gaming.

Comparison of Correlates of Active and Non-Active Gaming

Attitude appeared to be an important personal correlate for both active and non-active gaming. With respect to active gaming, on one hand, active gamers (≥1 h/wk) had a more positive attitude toward active gaming than adolescents who play active games <1 h/wk. This result suggests that it is important that adolescents have a positive attitude toward active gaming when aiming to replace non-active games with active games. On the other hand, we found that attitude toward non-active games was strongly negatively associated with active gaming ≥1 h/wk. Because of the cross-sectional design of the study, we do not know whether becoming an active gamer for ≥1 h/wk results in becoming less positive about non-active games or whether adolescents who are less positive about non-active games are more likely to turn to active games. The first could be positive for intervention strategies aiming at replacing non-active games with active ones. However, it might also be true that the more adolescents enjoy and favor non-active games, and thus form an important target group, the less likely they are to replace their non-active game play with active games, and therefore form a target group that is difficult to reach. Attitude toward non-active games was also a correlate for non-active gaming >7 h/wk. Attitude toward non-active gaming was negatively associated with active gaming ≥1 h/wk and positively associated with non-active gaming >7 h/wk, which suggests it might be difficult to transform non-active gamers into active gamers.

Enjoyment is an important element of attitude, and intervention strategies should therefore consider the aspects that adolescents like about active games, namely, being physically active, interactivity, realistic body movements, one-to-one translation of their movements into the game, and playing with other people [14]. Although studies have shown that many adolescents enjoy playing active games, in the long term, boredom often strikes and use declines over time [14,15,46]. The aspects of video games that make them attractive in the long term are online modus, multiplayer options, and the opportunity to improve oneself [14]. Lyons et al showed that multiplayer options were prevalent in half of the 18 evaluated active games [49]. The most prevalent behavioral strategy was performance feedback (in 17 of the 18 active games), which opens up the opportunity to improve oneself. To ensure long-term enjoyment in active gaming, it is important that more active games include one of these features and that game developers develop more active games that remain enjoyable in the long run.

Habit strength was associated with both active ≥1 h/wk as well as non-active gaming >7 h/wk, suggesting that playing both types of gaming is a habitual activity. This is an interesting finding for future interventions targeting game behavior because habitual behaviors may be more difficult to change and require different strategies than nonhabitual behaviors [50]. For example, intervention strategies based on information provision might not be effective because the habitual behavior (gaming) may override the attentional mechanisms needed to process such information [51,52]. Habits are triggered by situational and environmental cues; therefore, behavior change strategies should focus on incorporating environmental cues [53]. For strategies aimed at replacing non-active games with active games, one may consider placing the active game console in a highly visible place so that it can serve as a cue for playing. On the other hand, the non-active game console should be placed in a less visible place to prevent it from serving as a cue for playing. Findings from a focus group study confirm that seeing an active game console serves as a cue for playing it [14].

Descriptive norm non-active gaming of friends was a correlate of non-active gaming >7 h/wk. Adding the finding that descriptive norm active gaming of friends was a correlate for active gaming ≥1 h/wk makes modeling behavior of friends an important factor for game behavior. Remarkably, non-active game behavior of brothers and sisters was not associated with non-active gaming >7 h/wk, because active game behavior of brothers and sisters was for active gaming ≥1 h/wk.

Limitations and Strengths

The present study is subject to some limitations that need to be acknowledged. First, the cross-sectional design precludes any inferences from being made about causal mechanisms. Second, all measures were based on self-reported information, which may suffer from recall bias and socially desirable answers. Although we based the measures upon readily existing instruments, some of the scales had to be shortened to avoid a lengthy questionnaire. Doing so might have influenced the validity of the included measures. However, if a scale was shortened, we removed the items with the lowest factor loading, minimizing the possible negative influence on validity. Nevertheless, the use of selected items from validated scales is a limitation of the present study. Furthermore, we chose cutoff values for active and non-active gaming of 1 and 7 h/wk, respectively, which is arbitrary. There are no recommendations for the maximum time spent playing video games; therefore, we based our cutoff values on the results of previous studies and calculations for recovering the energy imbalance estimations [19-21,23].

One important strength of the current study is that it is the first to compare correlates of both active and non-active gaming. Furthermore, we included a wide range of personal, social, and game-related variables, which were based on behavioral theories and the outcomes of focus groups. The current study provides important new insights into personal, social, and game-related correlates of both active and non-active gaming.

Conclusions

Various factors were significantly associated with active gaming ≥1 h/wk and non-active gaming >7 h/wk. Active gaming is most strongly (negatively) associated with attitude with respect to non-active games, followed by observed active game behavior of brothers and sisters, and attitude with respect to active gaming (positive associations). On the other hand, non-active gaming is most strongly associated with observed non-active game behavior of friends, habit strength regarding gaming, and attitude toward non-active gaming (positive associations). Habit strength was a correlate of both active and non-active gaming, indicating that both types of gaming are habitual behaviors. Although these results should be interpreted with caution because of the limitations of the study, they do provide preliminary insights in potential correlates of active and non-active gaming, which can be used for further research as well as preliminary direction for the development of effective intervention strategies for replacing non-active gaming by active gaming among adolescents.

Acknowledgments

We acknowledge the participating schools for their collaboration. Furthermore, we thank all of the participating students for their contributions. In conclusion, we thank Elly Konijn for her feedback on the questionnaires and Myrna van Kessel for her contribution to data cleaning and preparation. This work was supported by a grant from The Netherlands Organization for Health Research and Development (grant number: 120520012).

Conflicts of Interest

None declared.

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Abbreviations

GEQ: game engagement questionnaire
h/wk: hours per week
PA: physical activity
RAI: relative autonomy index
SDT: self-determination theory
TAM: technology acceptance model
TPB: theory of planned behavior

Edited by G Eysenbach; submitted 08.11.13; peer-reviewed by E Lyons, S Allsop; comments to author 09.01.14; revised version received 04.03.14; accepted 10.03.14; published 04.04.14.

Please cite as:
Simons M, de Vet E, Chinapaw MJM, de Boer M, Seidell JC, Brug J
Personal, Social, and Game-Related Correlates of Active and Non-Active Gaming Among Dutch Gaming Adolescents: Survey-Based Multivariable, Multilevel Logistic Regression Analyses
JMIR Serious Games 2014;2(1):e4
URL: http://games.jmir.org/2014/1/e4/
doi:10.2196/games.3092
PMID:25654657

Publisher:
JMIR Publications
130 Queens Quay East.
Toronto, ON, M5A 3Y5
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Email: support@jmir.org