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Using videogames to treat childhood obesity

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Childhood obesity is one of the most dangerous pathologies; it can lead to serious illness in the absence of medical support. In this article we give an overview of the use of videogames for reducing and normalizing the weight of overweight and obese children. We discuss the categorization of the existing games and their limits, and we outline the perspectives of psychopedagogical research in the domain of game design for treating obese and overweight children. The role of long-term motivation in the treatment of obesity is one of the crucial questions we discuss. We try to understand how videogames can help children and parents maintain motivation during weight-loss treatment. The role of parents is undeniable in ensuring the success of weight-loss programs for overweight or obese children. Perhaps videogames can be the instrument for families' lifestyle changes.

Keywords: childhood obesity, videogame, motivation, family, lifestyle

Childhood obesity

Childhood obesity is one of the most important risk factors for the incidence of cardiovascular disease and diabetes in adulthood. Childhood obesity not only is common in developed countries but increasingly affects developing countries. Because of the consequences of childhood obesity — obesity in adulthood, cardiovascular disease, diabetes, arthritis — obesity has become one of the leading causes of death in the world (*Rapport sur l'organisation de la recherche …*, 2010).

Childhood obesity has taken the form of an epidemic since the mid-1990s (*Rapport sur l'organisation de la recherche …*, 2010). One single indicator, the Body Mass Index (BMI), usually determines adult obesity. It is calculated as the ratio of weight in kilograms to the square of height in meters. Individuals whose BMI is 25 to 29.9

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are diagnosed as being overweight. The diagnosis of "obesity of the first degree" is made when the BMI is 30 to 34.9; "obesity of the second degree" is pronounced when the BMI is 35 to 40. "Morbid obesity" is diagnosed when the BMI is over 40. In the case of children it is not enough to know only the BMI; it is necessary to correlate it with an interval of the rate of growth for the relevant age. For example, in France about 10% of children (from 3 to 16 years old) are obese, and about 19% are overweight (Sassi, Cecchini, & Devaux, 2012).

A report of the Institut national de la recherche agronomique (France) (2010) indicated that the number of children who were overweight didn't change from 1997 to 2007. According to the Ministry of Health in Russia, about 19.6% of boys and 5.5% of girls from 5 to 15 years old are overweight, while in Moscow the number of children with a BMI above the norm is 30% more than in other regions (Briz, 2008).

These statistics suggest a joyless future. Taking into account that "the chance that a child suffering from obesity will continue this pathology in adulthood ranges from 20 to 50%, if obesity is diagnosed before adolescence; if the diagnosis of obesity is made for a teenager, this probability varies from 50% to 70%" (Branca, Nikogosian, & Lobstein, 2007, p. 23). We can suggest that the level of diseases (diabetes, cardiovascular disease, arthritis) associated with obesity in adulthood will also increase, and they will be manifested at an increasingly early age (*Prévention, dépistage* …, 2012).

Studies that identify the factors associated with obesity show that a lack of physical activity and an unbalanced diet are the main direct factors. Genetic factors are responsible for 1% to 6% of childhood obesity (Klump, Kaye, & Strober, 2001). The economic and socioprofessional situation of parents is also associated with children's being overweight or obese, as are low income, poor social environment, and low parental education (Institut national de la recherche agronomique, 2010).

Videogames in childhood: Do they matter?

Videogames are based on the approaches to play in human development. The effect of play on general child development is a running theme for some of the most prominent educational psychologists. Play creates possibilities for children to (a) have social experiences and simulate alternative emotional states and feelings, which can then bring about resolution outside the play context (Erikson, 1977), (b) reproduce real-life dilemmas and complicated situations and then work out perfect resolutions and overcome unpleasant feelings (Piaget, 1962), (c) have a basis for fostering the development of social cognition (Piaget, 1962; Vygotsky, 1930–1934/1978).

Today, games, gamifications, and videogames in particular have a primary role as media of human development. Previous decades saw an expanding role for new media in the area of psychosocial development in childhood. As a medium for entertainment and education, videogames constitute a multi-billion-dollar industry. They are, for example, present in two of three U.S. households: every second American citizen plays a videogame; the average age of videogame players is 33

years; approximately 90% of children 2–17 years of age play videogames (NPD Group, 2011); over 45% of U.S. teenagers spend more than 2 hours per day playing (American Academy of Child & Adolescent Psychiatry, 2011; Entertainment Software Association, 2012; Granic, Lobel, & Engels, 2014; Trust for America's Health, 2007). These data indicate the extensive inclusion of videogames in modern society and in children's lives in particular.

Today's children are sensitive to the new digital era; they have grown up in the 21st century with a new interactive domain and are involved in consuming new entertainment media and technologies. We'll discover a new, crucial role for videogames in the educational and psychosocial experience of children and teenagers in relation to themselves, their parents, educators, and society. Internet surfing, chatting via social networks, as well as playing videogames are now the most common leisure activities in childhood. Being financially accessible to most children, entertaining and attractive videogames are available to them mainly via modern mobile devices and social networks that involve users of all ages, genders, social and financial backgrounds.

Depending on the research, authors fall into two different camps: one side approves and the other disapproves of the effects of videogames on children's and adolescents' psychosocial development, health, and education. So trying to understand the effects of videogames on the basis of modern research can be confusing and contradictory.

On the one hand, some studies indicate increasing aggression and increased blood pressure while playing games based on violent content. However, no significant negative social consequences (for example, an increase in the rate of juvenile violent crimes) have been identified. On the other hand, researchers believe well-designed videogames may promote learning and the development of higher-ordered cognitive processes and skills such as thinking, memory, concentration, and attention, and may stimulate imagination as well as the development of problem-solving and multitasking skills, motor skills, and complex learning (Tumbokon, 2014).

Videogaming is supposed to be a *stimulating learning experience* and *social activity*. In comparison to passively watching television, playing videogames stimulates active or even proactive behavior that usually challenges children and motivates them to achieve goals (Gee, 2003). An educational and generally positive characteristic of videogames is the interactive and decision-making capacity of the medium. Since the beginning of the century, the ability of videogames to represent complex, diverse, and realistic social content has changed dramatically (Ferguson & Olson, 2013). Videogames encourage children's role-playing; they become an important part of the game's script while playing with their favorite characters and consequently making decisions that imitate the actions of the character they follow (Anderson & Dill, 2000). By playing educational games, a child can acquire skills in strategy and *management*, *mapping and pattern recognition*, *decision-making in complex situations,* as well as literacy and numeracy (Tumbokon, 2014).

There are concerns about the opposite effects of excessive videogame playing among young people. Some popular videogames promote the killing of people

or animals, binge drinking and the use of drugs, asocial and criminal behavior, misdemeanors and breaches of the peace, debauchery, sexual exploitation, racism, gender stereotyping, obscene language and gestures, and other negative behaviors (American Academy of Child & Adolescent Psychiatry, 2011).

Attention-deficit disorders are one of the unwished-for consequences for most parents and educators. Researchers from Iowa State University (Iowa State University News Service, 2011) found that children whose parents did not limited their game playing were up to twice as likely to have attention problems (like attention-deficit hyperactivity disorder) as those whose game playing was controlled by their parents. An accompanying syndrome, loss of sleep, usually begins to develop as a reaction to a high level of adrenaline (especially when playing action games) and unusual brain activity.

Violence, aggression, and lack of social balance are seen as the most negative flip side of videogames (Ferguson, 2013; Lemola et al., 2011) as violent games become increasingly popular for both boys and girls at all grade levels (Cesarone, 1998). Intense videogames require the investment of time and other resources and influence children's social environment. Some authors state that children lack sufficient social relationships and interactions and have poor social skills because of the time spent playing videogames (Barenthin & Van Puymbroeck, 2006).

Young children playing videogames appear to have a heightened level of violence immediately after the game (Barenthin & Van Puymbroeck, 2006). Players of violent videogames have a higher level of aggression in response to confrontation than do those who do not play such games (Bushman & Anderson, 2002).

Other empirical data show that violent behavior is not influenced by videogames (Gunter, 2012). Most parents agree that the games are positive for their kids. For instance, a decrease in depression and anxiety symptoms as well as lowered levels of tension, anger, fatigue, and confusion have been detected in videogame players (East Carolina University News Service, 2011).

In reference to obesity, videogames themselves appear to be an influential source for uncontrolled behavior and consequently for binge eating and drinking and other unhealthy behaviors. Among U.S. teenagers, every seventh glued-to-the-screen game player is overweight (Trust for America's Health, 2007). There is a positive correlation between daily time spent on games and obesity: children who spend much of their leisure time playing videogames are much less active than those who do not play or play less. Inactive children gradually participate less in the motor activities and active behaviors that keep them fit and in healthy condition.

Videogames are a double-edged sword and, like many other contemporary media, are controversial. There is a thin boarder between a healthy amount of gaming and its positive effects and an excessive amount of gaming, which can lead to addictive behavior, social isolation, and reduced emotional and cognitive development. However, increased understanding of the proper use of videogames can lead to avoidance of the negative consequences of the medium, such as the development of psychosocial difficulties in children and their being at risk for obesity and for the degeneration of their health.

Using serious videogames to treat overweight and obese children

Various programs have been designed to treat childhood obesity by changing eating behavior or enhancing physical activity or both. The effectiveness of these programs is difficult to assess because we lack longitudinal studies (Schutz, 2004).

Reducing or stabilizing a child's weight is a problem that demands the participation of the whole family. Lobstein, Baur, and Uauy (2004) indicate that the reduction and stabilization of a child's weight is consistently effective and long-lasting if the whole family is actively involved in the program. Scientific studies have found that the active participation of parents is a necessary condition for a child's adherence to such a program (Golan & Crowt, 2004; Melbye, Ogaard, Overby, & Hansen, 2013). However, research on the intrafamily factors associated with obesity is scarce (Lobstein et al., 2004). Some studies have found that the changes in modern families, especially in family authority, pose special difficulties in the mental development of children and may even affect their physical health (Girerd, Druzhinenko, & Lesourd, 2007; Lebrun, 1997; Sauret, 2006). The report of the French senator Brigitte Bout (*Rapport sur l'organisation de la recherche . . .* , 2010) on the "organization of research and prospects for treatment and prevention of obesity" pointed out that the development of knowledge in the fields of intervention, adequate motivation, and interactive communication should become a center of scientific research regarding childhood obesity. The context of modern life seems to encourage the development of a sedentary lifestyle (Lobstein et al., 2004). Television and videogames are the main causes of the immobility of children.

On the basis of the special attraction of kids to videogames, several research and development teams decided to design games (for example, LABSITEC, HopeLab, Archimage) that would make kids more aware of healthy eating habits and of the value of physical activity. Since the turn of this century, videogames have entered the domain of health care. They are used for "serious" purposes, including the treatment of overweight and obese children. We carried out a critical analysis of existing videogames designed for this purpose in our previous work (Arambarri, Druzhinenko-Silhan, & Schmoll, 2014). In this article we focus only on some main results of our analysis in order to emphasize the value of this approach, the limits of existing serious videogames, and the kinds of research and applications that could be considered.

Two categories of "obesity-treating" games

The two main factors in gaining excess weight are caloric input and power expenditure. Either the individual consumes a lot of "bad" food (has an unbalanced diet, eats a lot of fat and sugar) or the individual does not expend calories (takes part in no or little physical activity). Thus, we can distinguish two categories of serious videogames: those that aim to change eating behavior and those that aim to increase physical activity.

The first category can be described as educational games. The interface of these games often involves interactive communication with the players in order to inform them about healthy food and healthy eating habits. It has been suggested that such integrated knowledge will lead to necessary changes in eating behavior. As

outlined by Baranowski, Buday, Thomson, and Baranowski (2008), the assessment of the long-term outcomes of such games is quite problematic. Indeed, the majority of studies indicate the immediate results, measured immediately after the game (Baranowski et al., 2007). For example, it was shown that after playing one of these educational games, children are more aware of healthy eating habits and make more correct snacking choices than previously (Majumdar, 2013). Nevertheless, these results were not powerful enough to assess how long the healthy eating habits might last. Therefore, it is not clear whether the game was effective. Also, the "source" of eating habits is not the children. Their parents purchase the products and prepare food for them. Indeed, children's assimilation of knowledge about eating behavior may face their parents' absence of such knowledge. This fact creates a huge obstacle to the construction of a healthy lifestyle.

Knowledge is necessary but it is not enough to change eating behavior. Thomson and colleagues (Thompson et al., 2010) argue that changes in behavior are based not only on knowledge but also on the experience of "self-efficacy" as well as on observing the behavior of others facing the same problem. Another important component of behavior change is the presence of a conscious intention to change the actual behavior (Thompson et al., 2010). So we can question the advisability of using only intrinsic motivation in the design of serious videogames without making children aware of the need to change their attitudes toward food choice. A good serious videogame could serve as an amazing support to a kid who is aware of the real goal of the game.

Games of the second category, those that aim to enhance physical activity, are generally known as training games. Usually the term *exergame* is used to describe them. Increased physical activity and its beneficial effect on BMI after playing exergames have been shown in many studies (for example, Staiano, Abraham, & Calvert, 2013). Indeed, children are more able to control and influence their physical activity than their plates. We also suppose that it is easier for children to feel the effectiveness of their actions in this kind of game than in an educational game. The success of the Dance Dance Revolution (DDR) shows that this kind of game can increase physical activity and can also create new social links. Dancing together is a pleasure in itself with some elements of competition, but, basically, it is a mutual sharing of joy and fun. A child playing in the DDR learns new moves and can enjoy listening to music in the company of friends. These elements of game design alone are sufficient to indicate that the DDR provides the necessary conditions for maintaining motivation: musical score, physical training, a community of peers, the ability to see other people doing the same thing, the ability to take a leadership position (Yim & Graham, 2007). This game allows children to feel their bodies and their possibilities and limits. DDR is an easy game, easy to take part in, and fun. The commercial success of DDR is proved by its one million sales per year (Puissance Nintendo, 2008). Even though such success is difficult to dispute, we may ask whether this game is adapted for obese individuals; it requires physical exercise, which is not always possible for them.

Another leader in sales, Wii Fit, has the same qualities as DDR and similar success. Both games, however, take into account only caloric expenditure. A literature review failed to find longitudinal studies of motivation in this kind of game (Aram-

barri et al., 2014). So the question about the stabilization of BMI by exergames remains unanswered.

A new category of serious videogames for treating obesity has appeared. These games attempt to combine educational and training modules. From our point of view, this approach is the most promising because it affects both parameters simultaneously: caloric intake and its expenditure. However, we still need studies of a sufficiently large sample to analyze the effectiveness of these games.

Table 1 analyzes serious videogames that aim to reduce and stabilize weight. The following characteristics are described: What kind of changes are the goal? What age group is targeted? Is there relevant research?

Table 1. Serious videogames for reducing and stabilizing weight

Game	Required changes		Target group			Relevant research
	Improvin-geating behavior	Enhancing physical activity	Child-ren	Adoles-cents	Adults	
Zamzee (HopeLab)		+	+	+	+	+
Konami's Dance Dance Revolution		+	+	+	+	+
Wii Fit		+	+	+	+	+
Red Hungry Planet	+		+	+	–	+
Fatworld	+		+	+	–	–
Play, Mate!	–	+	+			+
AR Quake		+		+	+	–
Neat-0-Game	–	+	–	–	+	–
Move2Play	–	+			+	–
Feeding Yoshi		+			+	+
Incredible Adventures of the Amazing Food Detective	+		+	+		+
Healthy Eating	+		+	+		–
Playnormous	+		+	+		+
Treasure Hunting (cloud-based pervasive game)	+	+	+	+	+	–
Bariagame	+	+			+	+
Escape from Diab	+	+	+	+		+
ETIOBE Mates	+		+	+		+
The Fantastic Food Challenge	+			+		–
Squire's Quest	+		+	+		+
PiNiZoRo		+	+	+		+

The main problem in all these games is that the scenario is exhausted after a fairly short time. Games are usually created so that they can be played for a few weeks or months. The research projects studied their effectiveness after this period, which is often too short for achieving sustainable results.

The problem of motivation: To create an endless game scenario

As we outlined above, treating overweight individuals (including children) requires special support that is available for a long period. Losing weight is a relatively easy goal, but sustaining the achieved results sometimes becomes an overwhelming task because it requires the maintenance of diet and of physical activity for at least three years to be insure that weight loss becomes stable (*Rapport sur l'organisation de la recherche . . .*, 2010). The aim of programs to treat obese and overweight children, who are constantly growing, is not to decrease but to maintain the actual weight because children will naturally reach a favorable BMI as they gain centimeters but keep the same weight. Nevertheless, support is necessary for several years.

Table 2. Motivation and reward systems in serious videogames

Game	Motivation system				Reward system		Goal of the game	
	Competition			Taking care of somebody	Real	Virtual	Specifically for weight loss	Modification of existing commercial game
	Individual	Dual	Team					
Zamzee (HopeLab)	+				+		+	
Konami's Dance Dance Revolution						+		+
Wii Fit	+	+				+		+
Red Hungry Planet				+				+
FFatworld				+		+	+	
PPlay, Mate!	+					+		+
AR Quake		+				+		+
Neat-0-Game	+							+
Move2Play	+					+	+	
Feeding Yoshi	+		+	+		+		+
Incredible Adventures of the Amazing Food Detective				+		+	+	
Healthy Eating						+	+	
Playnormous						+	+	
Treasure Hunting (cloud-based pervasive game)	+					+	+	
Bariagame						+	+	
Escape from Diab				+			+	
ETIOBE Mates							+	
The Fantastic Food Challenge	+		+	+		+	+	
Squire's Quest	+			+			+	
PiNiZoRo							+	

Thus, it is crucial that the games provide motivation. Table 2 presents a brief analysis of motivation and rewards in a selection of serious videogames.

As we can see from the table, most of the games created specifically as part of programs for weight loss use only one type of motivation. Neither competitive nor "caring" motivation is used in educational games, which aim to teach and to inform; the reward system is the basic motivation. Obviously, in the case of specially designed games, the main goal of the designers is to create something that obliges users to play. This goal raises the question of extrinsic and intrinsic motivation.

Extrinsic and intrinsic motivation

The concept of "serious videogames" is contradictory, even paradoxical, in itself (Schmoll, 2011). It involves two orders of motivation of two different involved agents: the creators and the customers (medical personnel, teachers, parents) of serious videogames are "serious," but their serious motivation is used to motivate the users (players, children and adolescents), who have a "playing" motivation. The juxtaposition of "serious" and "game" allows us to understand that, generally, as soon as children understand that the game is important for parents, they stop playing.

It is appropriate to talk about extrinsic and intrinsic motivation in exergames. These games are a kind of sports training or exercise. We can consider them sports simulators. When these games have a system of rewards that motivates children to play the game, they provide intrinsic motivation. When children are forced to play the game as if they are learning to ride a bike, the motivation is provided by the educational environment. The game stops as soon as the environment is no longer able to force the children to play the game. This type of motivation is called extrinsic motivation.

As we can see from Table 2, the gameplay process for most of the games designed specifically for weight loss is associated in most cases with medical support. Children are often informed that the game has a serious purpose. Thus, the serious aspect is dominant and leads to the prevalence of extrinsic motivation, so the playing component pales into insignificance.

A limitation of most existing videogames is that they are based on the motivating environment of the child; in other words, on extrinsic motivation. Extrinsic motivation can work if it is based on a specific pedagogical approach; it can motivate the child to play the game as if it is a serious occupation. But in many cases the cause of an unhealthy lifestyle is the weakness of the pedagogical (educational) framework. Thus, it is difficult to trust the pedagogical power of parents to create a new type of behavior. We can even hypothesize that gaming systems based on extrinsic motivation are appropriate only for users whose parents have a certain level of culture, which enables them to understand the benefit of nutrition and physical activity, as well as to have the time perspective required to stabilize weight. In other words, these games are shaped for a certain social stratum.

But if we want to make an interesting game for the maximum number of children, we have to rely on the support of their parents as much as possible, although the motivational system should be based primarily on the intrinsic game motivation. First of all, the game should remain a game.

Recommendations

Implementing games with unlimited scenarios

The necessity of creating games that lead to persistent changes in the lifestyles of children causes us to prioritize systems of motivation that allow the game to be fun for a long time, even for several years. This type of game will logically define the orientation of research in this area. Systems that offer addictive game space seem to be the only gaming systems that encourage the regular presence of a player in the game.

The first example of this type of game is a massively multiplayer online game (MMOG). Such games offer a permanent space enriched by the participation of the players, and they permit their game dynamics to last; in addition, they allow players to meet the whole online community of players in a unique space (Schmoll, 2008). Initially, these games are created on the basis of a common technical framework based on a single server that connects to the individual players' computers via the Internet. Players in these games can be involved in an adventure game for many years. The constant framework allows this type of game to be used in disciplines such as foreign languages because this type of learning necessarily requires staying for a long time in the conversation space (Schmoll & Schmoll, 2012).

Today, the use of transmedia technology allows us to consider the possibility of transpositioning the same game on a different technical support: on a personal computer, on a mobile phone, on the Internet, and, of course, in real space. A child will be able to use the play area in on-line mode, using 2D or 3D graphics, but the necessary gaming activities will be performed in reality. This transpositioning can be achieved by using GPS technology, by supporting motivation through mobile applications, and by communicating with peers in an area external to the game space—for example, with Internet forums, by searching for information on the special serious sites integrated into the game scenario.

Consolidating the two goals of healthy-lifestyle programs for obese or overweight children

Of the two categories of games—games aimed at increasing awareness of healthy eating behavior and training games, or exergames—the second category is easier to realize in practice. In spite of their limitations, caused by the deployment of short scenarios and a lack of analysis of long-term results, the performance of exergames is observable. Games aimed at enhancing awareness of eating behavior have the disadvantage that they are appealing only to the players' desire for knowledge: they do not guarantee that knowledge of nutrition rules will change eating habits. However, even if children would like to eat healthier meals, they have no control over menu ingredients and cooking methods. The area of children's real competence is physical activity, which they can more or less control. It is possible to identify the direction of research and development of these "making aware" games: (1) they should include gameplay for both children and parents. Parents will participate as players and not just as controllers of children's play activity; (2) they should include a feature capable of controlling players' food intake or, at least, of analyzing what

they have put on their plate. This feature will provide elements of real game scenarios and will permit (or not permit) rewards.

Carrying out longitudinal studies

As we have seen, games for treating obese and overweight children have been studied only for short-term effectiveness, and these studies are not sufficient. The time frame for research programs, usually about two or three years, is not always adequate. Because the treatment of obese children lasts for several years, we can require that performance evaluation be carried out over this long period. Our analysis highlighted the need for the study of factors that contribute to the maintenance of gaming motivation for a long period because the right eating habits and regular physical activity must be maintained over several years. Only a relatively long period of continuing a healthy lifestyle permits an individual to come back to a normal weight. Also, it is necessary to examine the role of parents and family in the successful implementation of programs for the reduction and normalization of weight gain in childhood. In addition, the "game" aspect of existing serious games is insufficient (Schmoll, 2011) and requires the identification of more subtle aspects of the psychological dynamics of individuals and appeal to peer relationships in order to create an interesting game, expecting as one of the results a change in families' lifestyles toward health.

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