

# Developing Games for Health Behavior Change: Getting Started

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## Abstract

Many investigators are considering developing videogames for health (video-G4Hs) but have questions about how to get started. This report provides guidance for investigators considering a G4H as a behavioral intervention procedure from a team of experienced G4H developers. Thirteen commonly asked questions are answered, including defining a G4H, considerations in developing a team, considerations in G4H design, and anticipating unintended consequences.

## Introduction

**G**AMES FOR HEALTH (G4Hs) PROVIDE an enticing medium for attracting attention and promoting changes in health and related behaviors. Thus, some health investigators are considering creating a G4H. Several of the authors have consulted on developing G4Hs with health research groups and individuals. Questions asked were remarkably similar. This report is organized around these commonly asked questions and provides the authors' perspectives. Where relevant references exist, we cited them. Where they didn't, we assembled our opinions regarding best practices. *Caveat emptor!* Although the report is directed toward health and behavior academics, videogame industry specialists may find some sections helpful.

## What is a Serious Video-G4H?

Game-based learning has been defined by identifying its principles and mechanisms.<sup>1</sup> The principles target intrinsic motivation, learning through "fun," authenticity (i.e., contextualized learning), self reliance/autonomy, and experiential learning.<sup>1</sup> Mechanisms include rules, clear but challenging goals, fantasy, progressive levels of difficulty, interactivity, player control, uncertainty, feedback, and a social element.<sup>1</sup> A player's effort is a physical or mental contest between the player and the game (i.e., "against the house") or between two or more players. A game identifies goals defining what the player is expected to do (i.e., save the world,

solve the mystery, etc.) using actions regulated by a framework of rules.<sup>2</sup> Many games contain thresholds for rewards or time limits to prevent activities from appearing too easy and thus boring.

Critical to the success of any game, serious or otherwise, is its ability to provide fun.<sup>3</sup> Digital experiences that resemble videogame entertainment by using game technologies, methods, and game-like art, but eschew mastery experiences (e.g., winning), competition, rules, or meaningful rewards, have been accused of missing the fun of videogames.<sup>3</sup> Boring games risk disappointing and, eventually, alienating their target audience. The degree of fun needed for a G4H compared with purely entertainment titles is a subject of debate.<sup>4</sup> A G4H may need to be only more fun than its traditional analog (health class, lectures from care providers, etc.).<sup>4</sup> Virtual reality simulation (immersion into computer-generated environments) by itself<sup>5</sup> and gamification (turning typically non-game activities into something game-like) without a game *per se*<sup>6</sup> are not considered in this article, but the same questions and answers may apply.

There are times when developing a G4H may not be an appropriate intervention approach. For example, there may be an existing G4H that can meet one's needs without creating a new one. Debra Lieberman's Web site of games and game-related research articles<sup>7</sup> is a good place to check on what's available. Developing a G4H can be expensive and requires substantial development time. A new G4H may not be the best idea if reasonable financing (likely tens of

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thousands of dollars or more) and adequate time (likely many months) are not available. Developing a game may not be a good idea for investigators who have never played videogames or do not enjoy playing them. For example, game mechanics are often learned and transported from existing games to G4Hs; if a game developer isn't familiar with game mechanics, it will be hard to develop a new game. Finally, developing a G4H requires large multitiered teams. Without access to such a team, or the resources to assemble it, a G4H may not be a good option.

### Where Might a G4H Be Delivered/Offered?

G4Hs have been offered in school classrooms,<sup>8</sup> on Web sites accessed from home,<sup>9</sup> videogame consoles,<sup>10</sup> computers for healthy children,<sup>11,12</sup> smartphones,<sup>13</sup> through a clinic for children with a disease,<sup>14</sup> and as part of Boy Scout troop activities.<sup>15,16</sup> Major issues in selecting a channel and technology (desktop computer, laptop, tablet, mobile game system, smartphone, or console game system) include (a) which technology reaches the largest number or percentage of targeted participants in a form they can easily and inexpensively access, (b) which platform or platforms permit the types of programming anticipated, (c) where the game or games will be played (e.g., on the bus to school, lunch break, in a classroom), and (d) when (e.g., during the commute to work, school time, leisure time). A G4H should be created using technology that will have the broadest reach to the targeted audience at the expected time of game availability (in the future), not its documented reach in the immediate past.

Another issue is alternatives available to occupy the intended participant's time. Schools are a desirable way to reach children in general (by age or grade) because large numbers of children are in schools and the alternatives to playing a fun game are didactic classroom lessons. Thus, within the context of school a particular G4H may be an attractive alternative. However, the same game offered on an elective basis at home may be unattractive, especially when the child has access to purely entertaining games, TV programs, or physical opportunities to engage with friends. Offering games in schools is not a simple proposition because school districts, subdistricts, principals, and classroom teachers may all have to agree to participate. School staff may need training to enhance their ability to provide/use the G4H as intended with the necessary sophistication to integrate it into classroom lessons. Networks of systems, schools, and teachers will need to be created and maintained with meetings to establish trust. To reach special target groups (e.g., Boy Scouts, Girl Scouts, children with specific illnesses), networks would also have to be built through these social, health, or other systems.

### What About Securing Funding?

Creating a videogame is expensive: From thousands of dollars for casual, short-duration games with minimal interactivity and simple art assets to millions of dollars for triple-A blockbuster titles with Hollywood special effects.<sup>17</sup> Several million dollars were available to create "Escape from Diab" and "Nanoswarm"<sup>11</sup> as two separate, but interrelated, G4Hs with 6–9 hours each of gameplay through high-level interactivity, animated cinematics (movie clips), three-dimensional environments, and other console videogame-like features.

Simple serious games have been created for low cost.<sup>18</sup> To overcome limited funding some serious game developers may offer researchers sweat equity and labors of love in exchange for future commercial sales. Knowing the finances available at the beginning of a game design effort will enable the team to realistically allocate appropriate resources.

The G4Hs industry currently lacks an effective business model<sup>19</sup> to fund initial design and development of games, update the games as needed, and generate sufficient revenue to support new games to address other needs as they are recognized.<sup>19</sup> Different funding mechanisms have enabled work in the G4Hs space: (a) Some grant recipients, health or health insurance companies, and corporations have contracted independent developers to create a G4H to meet their specific needs, (b) selling access to a G4H using licensing or subscriptions, (c) offering a service to companies for their employees, and (d) obtaining grant support from government sources.<sup>19</sup> Selling G4Hs to schools to meet health curricular requirements may become another business model, but this is currently untested. A leader of G4Hs in Europe indicated that in The Netherlands, health insurance companies would soon pay for G4Hs prescribed by a healthcare professional.<sup>19</sup> Crowd-sourced funding (i.e., announcing an investment or donation opportunity to the public and accepting their contributions) has been used to fund numerous entertainment videogames. A recent search of crowd-funder Kickstarter<sup>20</sup> found two entertainment videogames ("Torment: Tides of Numenera" and "Project Eternity") funded at around \$4 million each, although several serious game projects ("Phresh Kids Mat & Game: A Teaching Tool for Health & Peace," "Lunch Box" children's health and fitness board game, and "Emmett's Family Vacation—Getting Kids Up and Moving") were not funded. Ultimately, a successful G4H development team will need to become proficient in some form of commercialization.

### What Should We Consider in Assembling Our Team to Start This Project?

Creating a G4H is a multidisciplinary activity that differs from an entertainment-only videogame.<sup>4</sup> Because the goal of a G4H is to achieve a meaningful social or personal change, a balance is needed between "fun-ness" and "serious-ness."<sup>21,22</sup> The team needs to include "fun-ness" professionals (e.g., writers, artists, game designers, animators, sound professionals, computer programmers) as well as "serious-ness" professionals (e.g., behavioral scientists, targeted behavior content specialists, qualitative scientists, evaluation experts, developmental psychologists, psychometricians, biostatisticians).<sup>22</sup>

When contemplating potential game design team members, their skills, background, experience, previous participation in multidisciplinary teams, appreciation for diverse opinions, and "thinking outside the box" are necessary expertise. Once members are selected, clear roles and responsibilities, expectations regarding deadlines, and ground rules for resolving an impasse (i.e., who will make the final determination for a course of action) are required. Characteristics of the team leader also need to be considered. In a grant-funded G4H, the principal investigator (i.e., someone usually from the "serious-ness" side of the equation) is often the default team leader. Games funded through other sources may have a different model.

### What Should We Consider in Selecting a Company to Help Develop the Games?

The fun-ness game development team needs to include diverse professionals (identified above). Such skilled individuals may be found on a large university campus. Universities, however, often make teaching and other demands on faculty time that could preclude producing a product on schedule. Sometimes special units exist on large campuses that are tasked with media development, including games. Alternatively, many cities have companies whose specialty is creation of media, including videogames.

The best indicators of the effectiveness of a fun-ness side team may be the qualities of their previous games. Evaluating the art, animation, story, interactivity, sound, and game mechanics of existing games would be an important step in evaluating whether this is the type of product you want for your game. The team may assess a game's appeal to the targeted group by asking representative individuals to play the company's games and ask for feedback regarding indicators of "fun-ness." Another consideration is ease of communication with the fun-ness team leader and members. Differences in the criterion of success ("fun-ness" versus "behavior change") will necessarily conflict. Development cost is also an important consideration, but benefit-to-cost ratios may be difficult to derive, unless there is a standout candidate.

### What Are the Optimal Ways to Communicate with the Company Once Selected?

An essential step is establishing ground rules, which should be mutually discussed and approved. The team leader needs to clearly communicate expectations regarding the game (i.e., purpose, focus or content area, target audience, number of sessions) to the game design firm. A "problem-seeking session" is useful where these issues are carefully discussed, problem areas identified and negotiated, and possible solutions addressed early in the design process.<sup>23</sup>

There are many different ways to structure the communication process. In one project,<sup>12</sup> the team leader with expertise in the "serious" side of game design and key members of the game design firm with experience in the "fun" side met in advance and discussed the most effective way to approach the design process. The team leader and her team then created the theoretical framework, behavioral content, and behavioral procedures that needed to be included in the game. A game design document was created for the "serious" component. This was followed by several meetings with the game design team where each page of the design document was discussed, potential problems identified, possible solutions discussed, and a consensus reached regarding the final solution. A storyboard (which shows the game structure and provides an opportunity prior to programming to identify disconnects, repetition, gaps, etc.) was created and discussed in group meetings among the design (both "fun" and "serious") team, which enabled them to identify and resolve potential problems prior to programming.

### Who Owns the Game Once It's Developed?

Four kinds of intellectual property rights are associated with videogames: Patents, trademarks, copyrights, and trade

secrets. All are critical to understand, but copyright may be the most relevant to serious game development. In brief, copyright protects the expression of a videogame as conveyed through original software programming and artwork. The U.S. Copyright Act automatically assigns copyright ownership to the author of a work (i.e., the software programmer or game artist) unless specifically transferred to another party through a written agreement. An exception is when the programmer or artist is an employee of a company, in which case the company automatically owns the copyright. Without an agreement stipulating that a serious G4H is a "work made for hire," clients writing checks to serious game development companies may own nothing but the right to use the G4H for a limited purpose. Without a copyright transfer agreement, the videogame developers retains ownership of their work and the right to reuse their code at will or to sell it to others.<sup>23</sup>

Software developers sometimes agree to assign ownership to a client but retain the right to reuse their code on other projects. However, game developers may charge more for a G4H in which they will not fully own the copyright because the developer's potential for realizing future revenue from the work may be limited. Because the developer's risk for shouldering cost overruns (including those at no fault of the game developer) is high, extra fees to cover unanticipated expenses may be added to their quote when assigning copyrights. The best time to negotiate intellectual copyrights is well before work is initiated.

### How Do We Control Costs?

The videogame industry's history of colossal development expense leading to financial ruin<sup>24</sup> has led developers of both entertainment games and G4Hs to seek new methods of risk assessment<sup>25</sup> and workflow. One such method is called "iterative development,"<sup>26,27</sup> which is based on the idea of *not* knowing all of a game's needs upfront, allowing for short multiple cycles of development and user testing to uncover the game's final requirements. Each iteration produces "shippable" code (i.e., a videogame ready for distribution, albeit with incomplete gameplay). Although this is an effective technique, the downside is that the cost of game development is unknown during initial budgeting. An alternative would first establish a general budget and iterate game development until the budget is exhausted or the timeline for development can no longer be extended.

### Do We Need a Committee of "Experts"?

An element sometimes overlooked in designing a serious videogame is formative research (focus groups, interviews, surveys) with members of the target audience.<sup>12,21,28</sup> They can contribute important insights related to viability, acceptability, and comprehension (i.e., problems they encountered when playing the game, when they attempted to engage in the targeted behaviors, effective ways to overcome the problems, type of story and characters they enjoy, and whether they understand what you are asking them to do, they can do it, and it is acceptable/appealing). Parents are gatekeepers who control what children are exposed to in the home.<sup>29</sup> Formative research with parents identifies what they will allow in their home, including questions about focus area, content, cultural sensitivity, gameplay activities, length

of play, and their expectations regarding what the game would need to appeal to parents.

An “expert” committee of targeted participants may involve multiple rounds of formative research: (a) Identifying information needed to develop the game, (b) reviewing prototypes or “pieces of the game” (i.e., alpha testing), (c) assessing whether the team “got it right,” (d) usability testing (i.e., assessing ease of gameplay), and (e) beta testing (i.e., bug testing to identify technical problems). If the target audience is homogeneous (e.g., age, gender, race/ethnicity), a committee of 10 individuals may be adequate. If the target audience is diverse, a larger group may be needed to ensure adequate representation of subgroups. A helpful rule of thumb is 10 individuals per stratification characteristic (e.g., age, gender, race/ethnicity) or audience segment (e.g., children, parents, community representatives).

### What Should We Consider to Obtain Initial Behavior Change?

Using health behavior theory to guide intervention design may increase intervention effectiveness.<sup>30</sup> A G4H with higher fidelity to theoretical principles may produce greater behavior change.<sup>31</sup> Theories specify mediators, or mechanisms, by which behaviors may be modified. Rather than directly targeting a particular behavior, G4Hs target mediators, which, in turn, affect the behavior(s) and then the health outcome of interest.<sup>22</sup> These mediators guide interventionists to select empirically tested intervention procedures. For example, techniques for increasing self-efficacy for physical activity (a mediator) could be found by reviewing primary theoretical sources related to self-efficacy,<sup>32</sup> intervention planning texts that provide lists of commonly used techniques,<sup>33</sup> taxonomies of behavior change strategies,<sup>34,35</sup> or meta-analyses investigating effective techniques to increase self-efficacy in previously published physical activity trials.<sup>36,37</sup> Ideally, evaluations of previous interventions from the G4H literature would provide the strongest evidence. When such evidence is not available, consulting the larger intervention literature would be a next step. Both the relationship between the intervention technique and the mediator (known as “action theory”)<sup>38</sup> and that between the mediator and the behavior change outcome (known as “conceptual theory”) are important to incorporate in game design.<sup>38</sup> Both relationships need to be strong and causal, or behavior change is unlikely.

After selecting appropriate behavior change strategies, those strategies must be adapted for use in a G4H. Colleagues expert in applying these procedures and strategies can help. It may also be useful to assess strategies used in other G4Hs that target a similar behavior.

### What Should We Consider in Maintaining Behavior Change?

Little research has specifically addressed the issue of maintenance of behavior change among children. Behavior maintenance research among adults suggests that satisfaction with the behavior change process (i.e., personal assessment of whether the “benefits” of change were worth the effort it took to achieve change) was associated with behavioral maintenance.<sup>39</sup> Research is needed to understand this issue, especially among children. Potential methods to promote behavioral maintenance include enhancing intrinsic motiva-

tion to engage in the behavior by emphasizing and enhancing basic psychological needs (i.e., autonomy, competence, relatedness).<sup>40</sup> Populating a game with characters and a storyline thought to be personally relevant by the target audience may enhance attention and depth of information processing,<sup>41</sup> thus creating an environment in which observational learning can occur.<sup>42</sup>

### What Are Other Key Issues in the Design of a G4H?

#### *Game mechanics/interactivity*

Game mechanics are a videogame’s functional elements (i.e., its rules, means, and methods of playing). Entertainment game mechanics include role playing, moving around, tile matching, taking turns, collecting points, and attacking or defending something or someone. G4H developers often use entertainment game mechanics meant for different contexts,<sup>43</sup> and examples of poor G4H mechanics abound.<sup>4</sup> A G4H intervention can be thought of as rendering a serious purpose into a playable “what” and “how.” The “what” is the game’s serious content (e.g., health knowledge and behavioral algorithms). “How” is the means of delivering the content through fun. If designing a G4H were rocket science, content would be the rocket’s payload, and the delivery vehicle would be the game’s mechanics. Serious game mechanics should be equally matched to content and the game world in which it operates. Like the success of any transportation system, matching payload (what) to vehicle (how) and environment is critical.

#### *Story*

Because an audience’s attitude can change when the individuals identify with a character’s expressed thoughts, emotions, and actions<sup>44</sup> and because stories improved health beliefs, attitudes, and behavior,<sup>45</sup> wrapping a story around a G4H’s behavior change procedures is attractive. Being immersed within a story suppresses an audience’s natural instinct to counterargue against story events, which decreases resistance to story messages.<sup>46</sup> In a study about story’s positive influence on health, these capabilities increased an audience’s potential investment in desired health behaviors.<sup>47</sup> Whether effective storytelling inside a G4H changes behavior is unclear. Blockbuster videogames are often packed with lavishly produced cinematics that advance the game’s intricate plot. However, many game players objected to cinematics, even those in very popular videogames,<sup>4</sup> wanting to participate in an unfolding story more than watch it unfold. Interesting stories can be implied via environmental cues (e.g., located in an ominous house on a dark and stormy night), interactions between characters (e.g., friendliness or aggressiveness), or even gameplay itself (e.g., hunting for clues to solve a mystery). Alternatively, popular puzzle videogames like “Bejeweled” and “Tetris” are abstract with no story context, and many physical activity games (e.g., Nintendo® [Kyoto, Japan] Wii™ “Sports Resort”) have minimal story context. How to balance narrative and gameplay remains an area of debate.<sup>4</sup> Whether G4H behavior change requires an overt story to be successful is a research question more than a requirement.

#### *Challenge/levels/flow*

The use of levels across which the difficulty increases is a common feature of videogames. The concept of flow has been

invoked to explain the increasing immersion in the game activity and enjoyment from the experience of facing and overcoming increasing challenges.<sup>48</sup> Flow has been proposed as accounting for the fun experienced in a game<sup>49,50</sup>; there appears to be a neurophysiological underpinning to the flow experience,<sup>51</sup> although this deserves further research.<sup>52</sup> Although matching challenge to a player's increasing competence may account for fun or enjoyment, challenge exceeding competence may lead to frustration, and competence exceeding challenge may lead to boredom.<sup>48</sup> Game designer knowledge and experience, as well as formative assessment, are the primary sources for knowing whether particular levels of challenge are appropriate for a target group to maintain the flow experience.

#### *Feedback mechanisms*

Performance feedback in a videogame can come in many forms: Points accumulated for game accomplishments, bars that change colors reflecting performance, sounds, video images, etc. User interface is important. Adults alpha testing one serious videogame reported they did not notice, or ignored, status bars reflecting accumulated points and specifically requested verbal feedback on their choices instead.<sup>14</sup> In a study testing whether negative feedback needed to be buffered by positive feedback provided before and after (i.e., "Oreo" feedback),<sup>53</sup> the preference for type of feedback varied by social class. Lower-income participants preferred the buffer, whereas middle-income participants did not.<sup>53</sup> Although more research is needed on optimal forms of feedback to enhance learning and behavior change in G4Hs, formative research would be valuable for any particular game.

#### *Incentives/rewards/points*

Although incentives (providing money, gifts, or points for obtaining a change) are a cornerstone of behavioral economics,<sup>54</sup> the role of incentives in behavior change has not been clearly delineated, with many studies providing ambiguous or no relationships.<sup>55,56</sup> Incentives were not identified as an effective intervention procedure among children for obesity prevention or treatment<sup>57</sup> and may be less effective when applied to more complex behaviors like diet or physical activity.<sup>56</sup> Alternatively, providing incentives may subvert a participant's intrinsic motivation to do the behavior,<sup>58</sup> leading to discontinuation of the behavior once the incentives are no longer provided. Making gameplay more rewarding by satisfying intrinsic needs for autonomy, competence, and relatedness may provide more sustained engagement than providing external rewards.<sup>59,60</sup> Rewards, such as achievements, may be most effective when they serve a social purpose<sup>61</sup> or provide unexpected positive feedback that is perceived as informational rather than controlling.<sup>59</sup> Social rewards (e.g., positive comments to the player from people important in that person's life or possibly from admired game characters) have been used to encourage behavior change to avoid the pitfalls of reduced intrinsic motivation.<sup>62</sup> Game developers need to carefully consider the role of incentives.

#### *Goal setting/transfer to real-life settings*

Goal setting has been identified as an effective behavior change procedure among adults.<sup>63</sup> Active implementation

intentions, a specific, detailed extension of goal setting, were an effective behavior change procedure among children (D.T., unpublished data). Thus, there is ample reason to use goal setting in G4Hs. In addition, G4Hs face the problem of having the player extrapolate what is learned in the G4H to his or her own real life. Introducing goal setting soon after learning should have occurred and asking players to set a goal that requires them to use what they learned in the G4H to achieve the goal in real life offer great promise of enhanced learning extrapolation.

#### *Tailoring*

Interventions that individually tailor behavior change goals, information provided to participants about local opportunities,<sup>64</sup> and/or motivational messages<sup>65</sup> have been consistently shown to be effective behavior change procedures. A great value of computers is the opportunity to provide individualized messages.<sup>66</sup> A downside for videogames, however, is that usually a questionnaire needs to be administered to obtain the basic information to use in tailoring, which can shatter immersion in the G4H. This problem has been minimized by simplifying long questionnaires to single item questions<sup>67</sup> and/or by using characters to ask questions within the context of the game such that it stimulates dialogue.<sup>11</sup>

#### **Are There Possible Unintended Consequences We Should Anticipate?**

A G4H may produce several unexpected and/or unintended consequences. Some consequences may influence the integrity or efficacy of study procedures or even affect health outcomes. For example, entertainment videogames and G4H have been associated with snack food intake.<sup>68,69</sup> Feelings of engagement in game environments and narratives may be double-edged swords: Although these feelings increase enjoyment and positive emotions,<sup>46,70,71</sup> they may also be associated with greater food intake than less engaging games.<sup>72</sup> It may be prudent to incorporate into the G4H counseling related to snacking during gameplay, perhaps through character dialogue.

Developers can take steps to ensure that G4Hs do not unintentionally produce negative health consequences. G4Hs played using a mouse, keyboard, and/or traditional gamepad controller are typically sedentary.<sup>73,74</sup> Encouraging children to play these games could increase their sedentary behavior time. Some G4Hs include statements reminding players to take regular breaks; other G4Hs cease functioning after a cut-point of play time has been reached. Controller-free devices, such as Microsoft's (Redmond, WA) Kinect™, require movement in game control and perhaps would be a healthier alternative.

Some G4Hs may take advantage of social support and influence via online social networking. For example, "Health-Seeker"<sup>75</sup> is a Facebook game for managing diabetes. However, there is always the possibility of negative social interactions such as bullying or breaches of privacy or safety.<sup>76</sup> When incorporating social aspects into game systems, developers can balance the potential benefits of online socializing with their potential drawbacks by controlling access to the social network.

G4Hs could also have unexpected positive consequences. Some G4Hs positively impact executive functioning, vision,

and cognition.<sup>77,78</sup> Narratives can increase feelings of relatedness and positive affect.<sup>70</sup>

## Conclusions

Developing a G4H is a complex enterprise. Investigators considering entering this arena would benefit from contemplating alternatives in various issues in G4H development and design and deciding if they have the resources to meet the challenges. This report may enable contemplating investigators to identify and consider alternatives in response to key issues.

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## References

- Perrotta C, Featherstone G, Aston H, et al. *Game-Based Learning: Latest Evidence and Future Directions*. Slough, UK: National Foundation for Education Research; 2013.
- Huizinga J. *Homo Ludens: A Study of the Play Element in Culture*. New York: Harper & Row; 1970.
- Olson CK. Children's motivations for video game play in the context of normal development. *Rev Gen Psychol* 2010; 14:180–187.
- Buday R, Baranowski T, Thompson D. Fun and games and boredom. *Games Health J* 2012; 1:257–261.
- Isaranuwatthai W, Brydges R, Carnahan H, et al. Comparing the cost-effectiveness of simulation modalities: A case study of peripheral intravenous catheterization training. *Adv Health Sci Educ Theory Pract* 2013 [Epub ahead of print]. doi: 10.1007/s10459-013-9464-6.
- Lin RJ, Zhu X. Leveraging social media for preventive care—A gamification system and insights. *Stud Health Technol Inform* 2012; 180:838–842.
- Health Games Research, UC Santa Barbara. *Health Games Research Database*. 2013. [www.healthgamesresearch.org/db](http://www.healthgamesresearch.org/db) (accessed June 14, 2013).
- Baranowski T, Baranowski J, Cullen KW, et al. Squire's Quest! Dietary outcome evaluation of a multimedia game. *Am J Prev Med* 2003; 24:52–61.
- Baranowski T, Baranowski J, Cullen KW, et al. The Fun, Food, and Fitness Project (FFFP): The Baylor GEMS Pilot Study. *Ethn Dis* 2003; 13(1 Suppl 1):S30–S39.
- Maddison R, Foley L, Ni Mhurchu C, et al. Effects of active video games on body composition: A randomized controlled trial. *Am J Clin Nutr* 2011; 94:156–163.
- Baranowski T, Baranowski J, Thompson D, et al. Video game play, child diet, and physical activity behavior change: A randomized clinical trial. *Am J Prev Med* 2011; 40:33–38.
- Thompson D, Bhatt R, Lazarus M, et al. A serious video game to increase fruit and vegetable consumption among elementary aged youth (Squire's Quest! II): Rationale, design, and methods. *JMIR Res Protoc* 2012; 1:e19.
- Beltran A, O'Connor T, Hughes S, et al. Alpha test of a video game to increase children's vegetable consumption. *Games Health J* 2012; 1:219–222.
- Beltran A, Li R, Ater J, et al. Adapting a videogame to the needs of pediatric cancer patients and survivors. *Games Health J* 2013; 2:213–221.
- Jago R, Baranowski T, Baranowski J, et al. Fit For Life Boy Scout Badge: Outcome evaluation of a troop & Internet intervention. *Prev Med* 2006; 42:181–187.
- Thompson D, Baranowski T, Baranowski J, et al. Boy Scout 5-a-Day Badge: Outcome results of a troop and Internet intervention. *Prev Med* 2009; 49:518–526.
- Meloni W. The Brief—2009 Ups and Downs. 2010. [www.m2research.com/the-brief-2009-ups-and-downs.htm](http://www.m2research.com/the-brief-2009-ups-and-downs.htm) (accessed May 6, 2012).
- Plass JL, Perlin K, Nordlinger J. The Games for Learning Institute: Research on Design Patterns for Effective Educational Games. 2010. <http://seriousgamesmarket.blogspot.com/2010/01/gdc-10-serious-games-summit-g4li-update.html> (accessed July 1, 2013).
- Baranowski T, Isaac F, Ashford C, et al. Business models for successfully maintaining games for health. *Games Health J* 2013; 2:64–69.
- Kickstarter Inc. *Kickstarter: Bringing creativity to life*. 2013. [www.kickstarter.com/](http://www.kickstarter.com/) (accessed July 1, 2013).
- Thompson D, Baranowski T, Buday R, et al. In pursuit of change: Youth response to intensive goal setting embedded in a serious video game. *J Diabetes Sci Technol* 2007; 1:907–917.
- Thompson D, Baranowski T, Buday R, et al. Serious video games for health: How behavioral science guided the development of a serious video game. *Simul Gaming* 2010; 41:587–606.
- Buday R, Tapia R, Maze GR. Technology-driven dietary assessment: A software developer's perspective. *J Hum Nutr Diet* 2012 May 16 [Epub ahead of print]. doi: 10.1111/j.1365-277X.2012.01255.x.
- Honorof M. How Video Game Costs Could Crash the Industry. *Tech News Daily*. 2013. [www.technewsdaily.com/17477-development-costs-crash-industry.html](http://www.technewsdaily.com/17477-development-costs-crash-industry.html) (accessed June 9, 2013).
- Tozour P. *Managing Risk in Video Game Development*. Gamasutra. 2013. [www.gamasutra.com/view/feature/](http://www.gamasutra.com/view/feature/)

- 191523/managing\_risk\_in\_video\_game\_.php (accessed June 9, 2013).
26. Kane DW, Hohman MM, Cerami EG, et al. Agile methods in biomedical software development: A multi-site experience report. *BMC Bioinformatics* 2006; 7:273.
  27. Larman C. *Agile and Iterative Development: A Manager's Guide*. Boston: Pearson Education, Inc.; 2000.
  28. Thompson D, Cullen KW, Boushey C, et al. Design of a website on nutrition and physical activity for adolescents: Results from formative research. *J Med Internet Res* 2012; 14:e59.
  29. Gruber KJ, Haldeman LA. Using the family to combat childhood and adult obesity [abstract]. *Prev Chronic Dis* 2009; 6:A106.
  30. Turner-McGrievy GM, Campbell MK, Tate DF, et al. Pounds Off Digitally Study: A randomized podcasting weight-loss intervention. *Am J Prev Med* 2009; 37:263–269.
  31. Rovniak LS, Hovell MF, Wojcik JR, et al. Enhancing theoretical fidelity: An e-mail-based walking program demonstration. *Am J Health Promot* 2005; 20:85–95.
  32. Bandura A. *Self-Efficacy: The Exercise of Control*. New York: W.H. Freeman; 1997.
  33. Bartholomew LK, Parcel GS, Kok G, et al. *Planning Health Promotion Programs: An Intervention Mapping Approach*, 2nd ed. San Francisco: Jossey-Bass; 2006.
  34. Abraham C, Michie S. A taxonomy of behavior change techniques used in interventions. *Health Psychol* 2008; 27:379–387.
  35. Michie S, Ashford S, Sniehotta FF, et al. A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALORE taxonomy. *Psychol Health* 2011; 26:1479–1498.
  36. Ashford S, Edmunds J, French DP. What is the best way to change self-efficacy to promote lifestyle and recreational physical activity? A systematic review with meta-analysis. *Br J Health Psychol* 2010; 15:265–288.
  37. Williams SL, French DP. What are the most effective intervention techniques for changing physical activity self-efficacy and physical activity behaviour—And are they the same? *Health Educ Res* 2011; 26:308–322.
  38. MacKinnon DP. Integrating mediators and moderators in research design. *Res Soc Work Pract* 2011; 21:675–681.
  39. Rothman AJ. Toward a theory-based analysis of behavioral maintenance. *Health Psychol* 2000; 19(1 Suppl):64–69.
  40. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol* 2000; 55:68–78.
  41. Petty RE, Cacioppo JT. *Communication and Persuasion: Central and Peripheral Routes to Attitude Change*. New York: Springer-Verlag; 1986.
  42. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice Hall; 1986.
  43. Baranowski T, Lieberman DA, Buday R, et al. Videogame mechanics in games for health. *Games Health J* 2013; 2:194–204.
  44. Cohen J. Defining identification: A theoretical look at the identification of audiences with media characters. *Mass Commun Soc* 2001; 4:245–264.
  45. Green MC, Brock TC. The role of transportation in the persuasiveness of public narratives. *J Pers Soc Psychol* 2000; 79:701–721.
  46. Lu AS, Baranowski T, Thompson D, et al. Story immersion of video games for youth health promotion: A review of literature. *Games Health J* 2012; 1:199–204.
  47. Moyer-Gusé E, Nabi RL. Explaining the effects of narrative in an entertainment television program: Overcoming resistance to persuasion. *Hum Commun Res* 2010; 36:26–52.
  48. Csikszentmihalyi M. *Finding Flow: The Psychology of Engagement with Everyday Life*. New York: Basic Books; 1997.
  49. Koster R. *A Theory of Fun for Game Design*. Scottsdale, AZ: Paragraph Press; 2005.
  50. Sherry JL. Flow and media enjoyment. *Comm Theory* 2004; 14:328–347.
  51. Nacke L, Lindley C. Affective ludology, flow and immersion in a first-person shooter: Measurement of player experience. *Loading J Can Game Stud Assoc* 2009; 3(5). <http://journals.sfu.ca/loading/index.php/loading/article/view/72/1> (accessed July 17, 2013).
  52. Mellecker R, Lyons EJ, Baranowski T. Disentangling fun and enjoyment in exergames using an expanded design, play, experience framework: A narrative review. *Games Health J* 2013; 2:142–149.
  53. Baranowski T, Beltran A, Chen T, et al. Structure of corrective feedback for selection of ineffective vegetable parenting practices for use in a simulation videogame. *Games Health J* 2013; 2:29–33.
  54. Zandstra EH, Miyapuram KP, Tobler PN. Understanding consumer decisions using behavioral economics. *Prog Brain Res* 2013; 202:197–211.
  55. Martin A, Suhrcke M, Ogilvie D. Financial incentives to promote active travel: An evidence review and economic framework. *Am J Prev Med* 2012; 43:e45–e57.
  56. Lynagh MC, Sanson-Fisher RW, Bonevski B. What's good for the goose is good for the gander. Guiding principles for the use of financial incentives in health behaviour change. *Int J Behav Med* 2013; 20:114–120.
  57. Martin J, Chater A, Lorencatto F. Effective behaviour change techniques in the prevention and management of childhood obesity. *Int J Obes (Lond)* 2013 June 12 [Epub ahead of print]. doi: 10.1038/ijo.2013.107.
  58. Teixeira PJ, Silva MN, Mata J, et al. Motivation, self-determination, and long-term weight control. *Int J Behav Nutr Phys Act* 2012; 9:22.
  59. Rigby CS. Finding the right rewards to sustain player engagement. Presented at the GDC (Game Developers Conference) 2009, Austin, TX, 2009. [http://www.immersyve.com/downloads/conference-presentations/AGDC\\_2009\\_Rigby.pptx](http://www.immersyve.com/downloads/conference-presentations/AGDC_2009_Rigby.pptx) (accessed July 17, 2013).
  60. Przybylski AK, Rigby CS, Ryan RM. A motivational model of video game engagement. *Rev Gen Psychol* 2010; 14:154–166.
  61. Antin J, Churchill EF. Badges in social media: A social psychological perspective. Presented at the ACM CHI Conference on Human Factors in Computing Systems, Vancouver, BC, 2011. <http://www.research.yahoo.com/pub/3469> (accessed July 17, 2013).
  62. Wolfenden L, Wyse RJ, Britton BL, et al. Interventions for increasing fruit and vegetable consumption in children aged 5 years and under. *Cochrane Database Syst Rev* 2012; 11:CD008552.
  63. Michie S, Richardson M, Johnston M, et al. The Behavior Change Technique Taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 2013; 46:81–95.
  64. Hobbs N, Godfrey A, Lara J, et al. Are behavioral interventions effective in increasing physical activity at 12 to 36 months in adults aged 55 to 70 years? A systematic review and meta-analysis. *BMC Med* 2013; 11:75.

65. Brug J, Oenema A, Campbell M. Past, present, and future of computer-tailored nutrition education. *Am J Clin Nutr* 2003; 77(4 Suppl):1028S–1034S.
66. Kreuter MW, Farrell DW, Olevitch LR, et al. *Tailoring Health Messages: Customizing Communication with Computer Technology*. Mahwah, NJ: Lawrence Erlbaum Associates; 2000.
67. Sladdens EF, Hughes SO, O'Connor TM, et al. The Children's Behavior Questionnaire very short scale: Psychometric properties and development of a one-item temperament scale. *Psychol Rep* 2012; 110:197–217.
68. Chaput JP, Klingenberg L, Astrup A, et al. Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obes Rev* 2011; 12:e12–e20.
69. Mellecker RR. Experiment on kids' snacking during video-game play on a sofa. *Appetite* 2010; 55:343–347.
70. Gabriel S, Young AF. Becoming a vampire without being bitten: The narrative collective-assimilation hypothesis. *Psychol Sci* 2011; 22:990–994.
71. Green MC, Brock TC, Kaufman GF. Understanding media enjoyment: The role of transportation into narrative worlds. *Commun Theory* 2004; 14:311–327.
72. Lyons EJ, Tate DF, Ward DS. The better the story, the bigger the serving: Narrative transportation increases snacking during screen time in a randomized trial. *Int J Behav Nutr Phys Act* 2013; 10:60.
73. Barnett A, Cerin E, Baranowski T. Active video games for youth: A systematic review *J Phys Act Health* 2011; 8:724–737.
74. Biddiss E, Irwin J. Active video games to promote physical activity in children and youth: A systematic review. *Arch Pediatr Adolesc Med* 2010; 164:664–672.
75. Diabetes Hands Foundation. Healthseeker: A Healthy Facebook Game. 2013. <https://apps.facebook.com/healthseeker/> (accessed July 1, 2013).
76. Kwan GCE, Skoric MM. Facebook bullying: An extension of battles in school. *Comput Human Behav* 2013; 29:16–25.
77. Green CS, Bavelier D. Learning, attentional control, and action video games. *Curr Biol* 2012; 22:R197–R206.
78. Spence I, Feng J. Video games and spatial cognition. *Rev Gen Psychol* 2010; 14:92–104.

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