

Behavioral Science in Video Games for Children's Diet and Physical Activity Change: Key Research Needs

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Abstract

Innovative intervention programs are needed to overcome the limitations in previous programs that promoted change in diabetes risk behaviors in children. Serious video games show promise of changing dietary and physical activity behaviors, but research is needed on the optimal design of behavior-change procedures in video games, the mechanisms that account for changes obtained, and the groups in which these interventions work best. Such research will permit the optimal design of serious video games for diabetes and obesity prevention in the future.

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Introduction

We are in the midst of an epidemic of obesity, which is a risk factor for type 2 diabetes.¹ While the dramatic increases in pediatric obesity have slowed, the prevalence is still very high, especially among ethnic minority children.² Most obesity prevention programs have not been effective.³ Innovative programs, based on the best theories necessary for understanding how to promote behavior change,⁴ are needed to initiate new interventions. Serious video games, i.e., games designed to attain a serious outcome (e.g., behavior change) other than simply enjoyment, show promise for promoting diet and physical activity behavior change.⁵ A conceptual framework is needed to understand how video games may induce behavior change, and research is needed to provide a firm foundation for the design of behavior-change procedures integrated into video games.

Conceptual Framework for Understanding Behavior-Change Interventions

The mediating/moderating variable model (MMVM) provides a framework for understanding how interventions may induce behavior change (**Figure 1**). While there is a substantial set of statistical techniques for establishing whether a variable mediates an intervention-to-behavior-change relationship,^{6,7} this article uses the MMVM simply as a conceptual framework to demonstrate how it can be used to guide the design of a serious videogame. The MMVM as a model for behavior change posits that interventions must be implemented as designed, adequately implemented interventions change mediating variables, changes in mediating variables induce behavior change, changes in behavior induce adiposity change,

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Abbreviations: (MMVM) mediating/moderating variable model, (USDA/ARS) United States Department of Agriculture/Agricultural Research Service

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and changes in adiposity influence diabetes risk (**Figure 1**). The key MMVM assumptions are that targeted behaviors are causally and substantially related to adiposity (otherwise, changes in the behaviors will not substantially affect adiposity), the targeted mediating variables are causally and substantially related to the targeted behavior(s) [otherwise, changes in the mediators will not substantially affect the behavior(s)], and procedures are available to change the mediating variable enough to change the targeted behavior enough to, in turn, reduce adiposity.⁸ The model in **Figure 1** identifies a single pathway from intervention implementation to type 2 diabetes risk with only one targeted mediating variable and one targeted behavior.

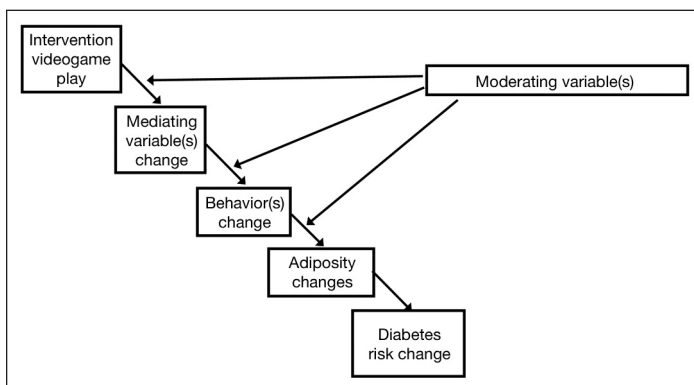


Figure 1. Pathway from intervention implementation to type 2 diabetes risk with only one targeted mediating variable and one targeted behavior.

diabetes risk with only one targeted mediating variable and one targeted behavior. The models undergirding real interventions can have multiple procedures, mediators (in parallel or in sequence), and behaviors (in parallel or in sequence). While there is substantial controversy about what behaviors influence adiposity,^{9,10} this article addresses the relationship of intervention procedures as incorporated in video games to change mediating variables.

A Model of Mediation of Behavior Change from Video Game Interventions

While little is known about effective mediation in non-video game dietary¹¹ or physical activity¹² behavior-change programs, even less is known about effective mediation of behavior change from video games or how to design behavior-change procedures to be maximally effective on mediators (and behaviors) in different groups (e.g., age, gender, videogame experience) under various circumstances (e.g., use in school, at home, on cell phones). A model of mediation of diet and physical activity behavior change using video games is presented in **Figure 2**. The intervention appears in orange, the psychosocial influences appear in blue, and the behavioral outcomes appear in green. This model is based on component ideas from four theories: self-

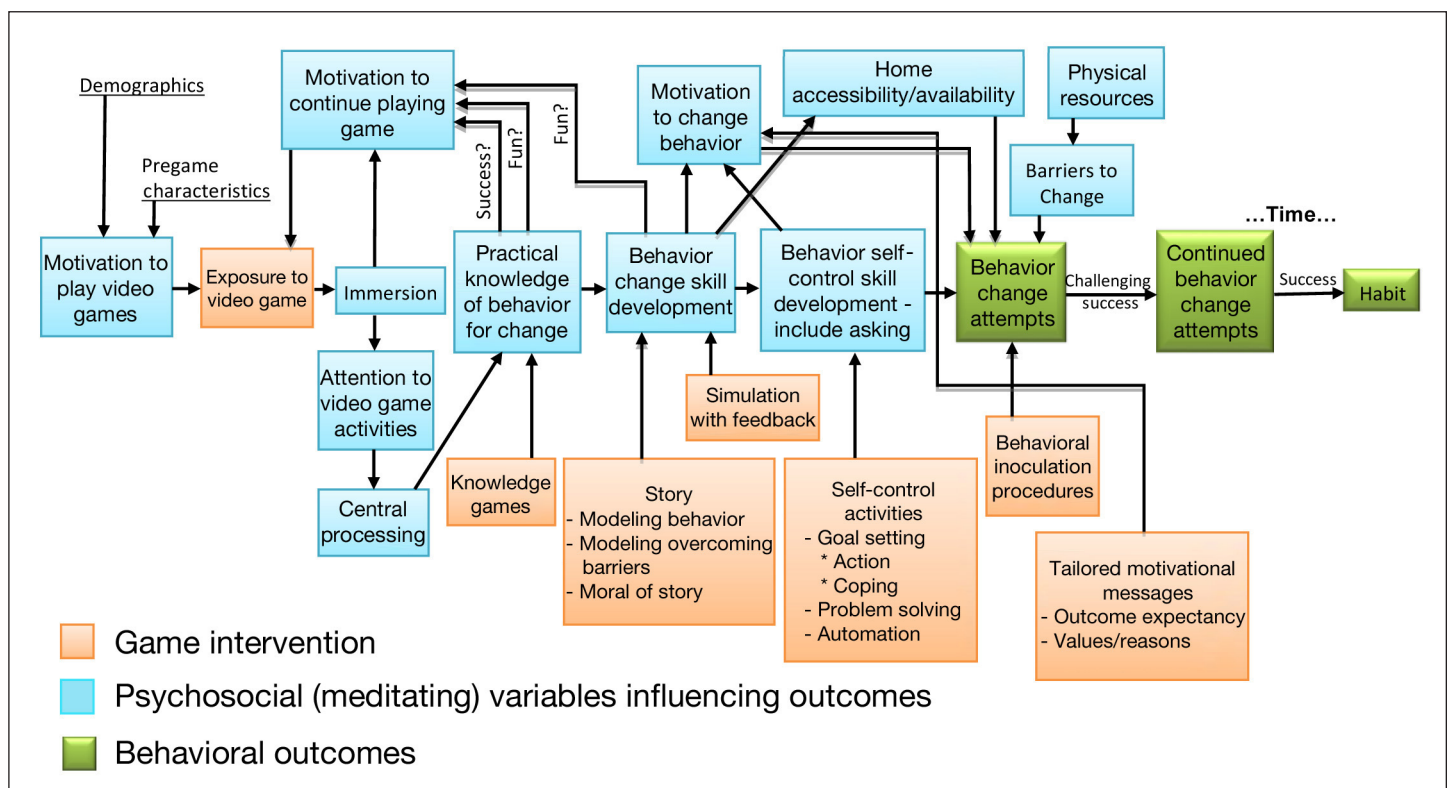


Figure 2. Model of how video games with component change procedures influence mediators to change behaviors.

determination,¹³ transportation,¹⁴ elaboration likelihood,¹⁵ and social cognitive.¹⁶

Self-determination theory addresses motivation to perform a behavior. In this model, motivation initiates the behavior-change pathway by influencing whether children will put themselves in situations where they are exposed to a behavior-change videogame, as well as their motivations to initiate game play, continue to play the game, and change the targeted behavior. Self-determination theory posits that behavior change is more likely maintained if it is intrinsically motivated.¹³

Transportation theory deals with stories and whether a child becomes immersed (or transported) in the story world.¹⁴ There is reason to believe that a child immersed in a story is more easily influenced by the messages embedded in the story.¹⁴

The elaboration likelihood model addresses a child's attention to the message and whether the child mentally wrestles with the behavior-change issues (called "central processing").¹⁵ Elaboration likelihood posits that paying attention to a message increases the likelihood of central processing.

Social cognitive theory deals with practical knowledge, development of the skills, self-control, and the environment.¹⁶ Social cognitive theory posits that practical knowledge is necessary, but not sufficient, for behavior change; the environment can influence what one eats (e.g., children who have more vegetables at home tend to eat more vegetables¹⁷), but skills are needed to make behavior changes, such as changing the environment; and self-control involves skills for limiting how much one eats.

A variety of procedures (orange boxes in **Figure 2**) have been proposed for promoting changes in behaviors.¹⁸ Knowledge games, based on mastery learning principles,¹⁹ can be introduced to enhance practical knowledge. Stories can be created²⁰ that immerse players and capture their attention to focus on characters who model desired behaviors and overcome barriers to behavior change. Simulation of behaviors can be conducted in virtual environments (e.g., recipe preparation²¹) to enhance familiarity with and skills for the behavior. Goal setting can be introduced to mobilize resources to achieve behavior changes²² and automate problem solving when problems or barriers arise.²³ Behavioral inoculation procedures can be introduced to challenge a player's resolve to change behavior and thereby further enhance

the player's resolve to change his/her behavior.²⁴ Tailored motivational messages can be provided to the player to enhance intrinsic motivation.²⁵ A review of video games regarding health-related behavior change⁵ demonstrated that positive outcomes were documented for 26 of 27 games in the peer-reviewed literature. However, the specific outcomes varied from just knowledge to complex behavior changes; the measures varied enormously; and even when the outcomes were positive, it was virtually impossible to attribute the change to a specific component of the game because of the complexity of the games.⁵

Research Challenges

Many of the previous intervention programs for preventing obesity,³ changing diet,²⁶ or enhancing physical activity²⁷ have not been successful among children. Within the context of the MMVM and video game interventions, the primary focus of this article is to explain that lack of effect is the linkage from the video game implementation of intervention procedures to desired mediating variable change. Attracting and maintaining a child's attention may be the biggest contribution of video games to health-related behavior change, but this has not been demonstrated.

The effect of each of the proposed intervention procedures identified in **Figure 2** on the corresponding mediating variable needs to be tested with different groups, under different circumstances, using alternative versions of the procedure. Do the procedures change the mediating variable enough to expect changes in the targeted behavior? And is the behavior change enough to influence the health outcome (e.g., obesity)? How can the design of the procedures (e.g., goal setting, tailored messaging, story components) be optimized to maximize the effect on the mediators (e.g., self-efficacy, outcome expectancy/attitudes, intrinsic motivation, practical knowledge)? To what extent do changes in the virtual situation (e.g., problem-solution identification) change the mediating variable (e.g., problem-solving behavior) to be operative in the real world in which the child functions? Or does the child need to personally face real-world challenges to enhance real-world problem solving skills?

The sequence of mediating variables in **Figure 2** reflect a logical rendering of how these influences should work, but there has been no research to confirm how they actually work. It is possible that some of these mediating variables are out of sequence, that others are not really that important, or that there are key variables not included in this sequence. Research is needed on all these issues.

A key attractive feature of video game play is the fun or enjoyment from playing the game. Research is needed to identify what makes game play fun, e.g., active involvement/interactivity, overcoming challenges, making virtual choices, receiving consequences without real personal threat, personally relevant story, or characters immersed in personally meaningful situations. Can fun be used to promote behavior change, treating fun as a reward (e.g., unlocking new games as behaviors change), or by having a desirable character meet and model overcoming challenges to behavior change that a player is likely to face?

Other research questions include (a) whether mastery learning procedures (e.g., repeated testing until a preset learning criterion is attained) in a game enhance learning of practical knowledge necessary to change a behavior; (b) whether immersion in a story focuses attention, and thereby enhances central processing, on the behavior-change message; (c) whether there are groups of children among whom these intervention procedures work, or work better (e.g., children who play many games); and (d) how an intervention can be optimally designed for the others.

Conclusion

We are in the earliest stages of understanding how serious video games can influence health-related behaviors.²⁰ Because video games are attractive to children,²⁸ they hold the promise of engaging children in behavior-change-promoting activities. Extensive research is needed to understand when and how these change procedures influence mediating variables and, in turn, behavior. The results will facilitate the design of ensuing serious video games for behavior change for large public health benefits.

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