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# Story Immersion in a Health Videogame for Childhood Obesity Prevention

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## Abstract

***Objective:*** Stories can serve as powerful tools for health interventions. Story immersion refers to the experience of being absorbed in a story. This is among the first studies to analyze story immersion's role in health videogames among children by addressing two main questions: Will children be more immersed when the main characters are similar to them? Do increased levels of immersion relate to more positive health outcomes?
***Subjects and Methods:*** Eighty-seven 10–12-year-old African-American, Caucasian, and Hispanic children from Houston, TX, played a health videogame, "Escape from Diab" (Archimage, Houston, TX), featuring a protagonist with both African-American and Hispanic phenotypic features. Children's demographic information, immersion, and health outcomes (i.e., preference, motivation, and self-efficacy) were recorded and then correlated and analyzed.
***Results:*** African-American and Hispanic participants reported higher immersion scores than Caucasian participants ($P = 0.01$). Story immersion correlated positively ($P$ values $< 0.03$) with an increase in Fruit and Vegetable Preference ($r = 0.27$), Intrinsic Motivation for Water ($r = 0.29$), Vegetable Self-Efficacy ($r = 0.24$), and Physical Activity Self-Efficacy ($r = 0.32$).
***Conclusion:*** Ethnic similarity between videogame characters and players enhanced immersion and several health outcomes. Effectively embedding characters with similar phenotypic features to the target population in interactive health videogame narratives may be important when motivating children to adopt obesity prevention behaviors.

## Introduction

Childhood obesity is a worldwide problem,[1] especially in developed countries like the United States.[2] Obesity increases the risks of type 2 diabetes[3] and various cancers,[4] shortens the lifespan, impedes functional ability, diminishes quality of life,[5] and tracks from childhood into adulthood.[6] Childhood obesity prevention incorporates fruit and vegetable (FV) and water intake and physical activity (PA).[7,8] Unfortunately, the level of FV intake and moderate-to-vigorous PA among U.S. children is below recommended levels.[9,10]

Many obesity prevention programs have not produced the desired effect[11]; however, health videogames offer an innovative alternative. Videogames have induced positive health behavior changes among children,[12] such as increased FV intake[13] and PA.[14] An important, but understudied, characteristic of videogames is the role of the narrative. Narratives or stories are a basic[15] and universally enjoyed[16] form of communication. Narratives can influence cognition, affect, and, potentially, health behavior,[17–19] through "transportation." Green and Brock[20] defined transportation as "a state in which a reader becomes absorbed in the narrative world" (p. 317) of non-interactive media such as novels. Transportation is the unique immersive quality that enables the suspension of disbelief,[21] provides vivid personal experiences,[22] and engenders a deep affection for the characters.[23] Videogames are interactive, with immersive qualities that are highly appealing to children. The word "immersion" likely better describes the involving nature of videogames; therefore, to avoid confusion, transportation during videogames will hereinafter be called immersion.

Character and plot are the main components of a narrative and are important determinants of its immersive quality.[24] A character is a crucial structural property,[25] providing the driving force of a narrative[26] and serving as an "internal" source of information or beliefs.[21] The plot, or the "narrative

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discourse," is how the story is conveyed. The plot also plays a pivotal role in story delivery by organizing events into a logically unfolding series[27] or temporal order.[28]

The close interaction between the audience and characters is an important mechanism that influences people[29] and makes the narrative personally relevant.[30] For characters to serve as models for a person's behavior, their perceived similarity and competence in carrying out the behavior are important.[31–33] Children who perceive themselves as similar to characters are more influenced by the media context in which these characters appeared.[34] African-American and Hispanic audiences have responded favorably to media featuring characters of their own race.[35,36] Children and adolescents are a highly imaginative group,[37,38] which may make them more receptive than adults to videogame narratives with fictional elements.[39] Therefore, videogames with appealing characters and immersive narratives could provide an innovative medium for children and adolescents that is easy to process, engaging to follow, and fun to experience.

Videogame immersion has received scant empirical investigation in obesity research. The current research explores the immersion of children and adolescents in a videogame for health, "Escape from Diab" (i.e., "Diab") (Archimage, Houston, TX), designed to lower the risk of type 2 diabetes and obesity by improving children's diet and PA behaviors.[40]

Extensive formative research was conducted with ethnic minority children to create the story and characters with whom these children could identify.[41] "Diab" featured African-American and Hispanic main characters because children from these two groups extensively play videogames[42] and are prone to obesity.[3] Cartoon-type characters from an ethnically diverse group were created based on formative focus group sessions with input from multiethnic panels of 76 middle school youth (81% were African-American or Hispanic).[43] Deejay, the protagonist who is also a healthy diet and PA expert, has both African-American and Hispanic phenotypic features. The other supporting youth characters of diverse ethnic background were created based on participants' input (Fig. 1). The plot of "Diab" was also informed by input from multiethnic youth.[41]

The two main questions in this article include: Will children be more immersed when the main characters are similar to them? Do increased levels of immersion relate to more positive health outcomes?

## Hypotheses

Two hypotheses were tested: (H1) African-American and Hispanic players will be more immersed in "Diab" than Caucasian players; or (H2) increased levels of immersion are related to more positive health outcomes.

Two research questions were also investigated: To what extent were there ethnic group differences in the health outcomes? How did immersion account for these differences?

## Subjects and Methods

### *Participants*

One hundred fifty-three children (103 in the intervention group and 50 in the control group) were recruited primarily with radio advertisements targeting African-American and Hispanic children in Houston, TX.[40,44] Listeners were provided a telephone number to call for more information on the study. A bilingual recruitment specialist conducted preliminary

**FIG. 1.** Main characters from "Escape from Diab." From left to right: Delinda, Bearspaw, Deejay, and Mayza. Color images available online at www.liebertonline.com/g4h

screening. Those who met initial criteria were forwarded to project staff to complete the screening; those who passed were scheduled for baseline assessment. Twice as many treatment as control group participants enabled substantial assessment of game play while maintaining the *F* robustness.[45]

Inclusion criteria were 10–12 years of age, between the 50th and 95th percentiles for body mass index, able to understand English, allowed to play videogames, and having high-speed Internet access (to permit transmission of process evaluation data). We used high normal and overweight children in this age group because (1) they are likely to become obese young adults,[46,47] (2) examining outcomes in a high-risk group is especially important,[48] and (3) interventions have had effects primarily among the overweight and obese.[48–50] Exclusion criteria were having a medical condition that influenced diet, PA, obesity, or the ability to complete questionnaires, a seizure disorder (due to exacerbation by electronic screen media), or a member of a swim team (due to limitations of PA assessment with accelerometers). The study was approved by the Baylor College of Medicine Institutional Review Board.

### *Intervention*

From 2008 to 2009, a two-group randomized control trial was conducted. The intervention group played "Diab." The original intervention project included two videogames. Besides "Diab," the other was called "Nanoswarm: Invasion from Inner Space" (Archimage). The "Nanoswarm" game was not included in this analysis because child participants played "Nanoswarm" after "Diab," and assessments were made immediately after each game and 2 months later. It was impossible to separate each game's influence if both were included in analysis.

Assessments were conducted at baseline and immediately after game play. There were nine sessions in "Diab," and each lasted a minimum of 40 minutes. The range of days for players to complete the game was 18–132. Most fell between 18 to 59 days, with only two taking longer than 2 months ($M=31$; $SD=16$). "Diab," told from the third person perspective, is a health game about Deejay, an athletic youth who accidentally falls into a nightmarish world called Diab, where he and his newly found friends must escape by adopting a healthier lifestyle. After the opening session, each subsequent session started with the resolution of the cliffhanger scene at the end of the previous session. A session-by-session description of each of the components of the game can be found in Baranowski et al.[40]

Each participant in the treatment group was loaned a 24-inch iMac® (Apple, Cupertino, CA) computer with "Diab" and Microsoft (Redmond, WA) Windows XP operating system preinstalled. At the end of each session, the player could return to the current or a previous session and replay the videogame session, but could not move on to the next sessions unless the time had expired for the goals set at the end of the most recent session (thereby allowing the goal to be achieved). The computers had no application other than the intervention games. The intervention coordinators monitored children's game progress through e-mails sent automatically when a session was completed, answered call-in questions, and solved minor hardware or software problems. The control group did not play either of the games but instead received a knowledge-enhancing Internet experience presented in two parts, each of which included eight sessions of game-based websites. The control group experience was offered to meet participants' expectations of playing health-related videogames to avoid a higher dropout rate.[51] Because the immersion questions were only applied to the intervention group, the control group is excluded from the current analyses. There were no significant differences in demographic variables between treatment and control groups (data not shown).

### *Assessment*

**Immersion.** Immersion was assessed immediately after children finished "Diab" using questions adapted from the narrative transportation scale of Green and Brock,[20] which demonstrated good internal consistency ($\alpha=0.89$). Items were summed. Sample items included: I can easily imagine the things that happened in "Diab"; I felt like I was part of the action in "Diab" (1=Do not agree; 2=Somewhat agree; 3=Agree a lot). The maximum possible score was 54, whereas the minimum possible score was 18.

**Key health outcomes.** Major predictors of FV and water consumption and PA include FV, Water, and PA Preferences (whether the child liked FV, Water, and PA).[21,52] Intrinsic motivation, from self-determination theory,[53] has been proposed as a key determinant of behaviors[54] such as healthy eating.[55] Self-efficacy has been a primary predictor of FV and water consumption[56] and physical activity.[57] Effective interventions should change the key determinants of the targeted behaviors.[58] In this article, preference, intrinsic motivation, and self-efficacy for FV, water, and PA were included as key health outcomes, and the items were summed for each after demonstrating good or acceptable internal consistency:

1. FV Preference was assessed using a 36-item validated scale (baseline $\alpha=0.84$; follow-up $\alpha=0.89$).[59] Each item, "We would like to know how much you like…?," asked about a different food (0=I never tasted this; 1=I do not like it; 2=I like it a little; and 3=I like it a lot).
2. Water Preference was assessed using a single-item scale similar to FV Preference (0=I never tasted this; 1=I do not like it; 2=I like it a little; and 3=I like it a lot).
3. PA Preference was assessed using a 28-item validated scale (baseline $\alpha=0.82$; follow-up $\alpha=0.86$).[60] Each item, "What activities do you like to do…?," asked about a different PA (e.g., bicycling, dancing, etc.) (0=I have never done it; 1=I do not like it; 2=I like it a little; and 3=I like it a lot).
4. Intrinsic Motivation for Fruit was assessed using a 12-item scale (baseline $\alpha=0.60$; follow-up $\alpha=0.73$). Sample items included "(Eating fruit) makes me happy; I enjoy eating fruit (0=no; 1=yes)."
5. Intrinsic Motivation for Vegetable was assessed using a nine-item scale (baseline $\alpha=0.63$; follow-up $\alpha=0.68$). Sample items included "It's important to me to eat vegetables; It's fun to eat vegetables" (0=no; 1=yes).
6. Intrinsic Motivation for Water was assessed using a nine-item scale (baseline $\alpha=0.70$; follow-up $\alpha=0.74$). Sample items included "Drinking water is good for my health; (Drinking water) makes me happy" (0=no; 1=yes).

7. Intrinsic Motivation for PA was assessed using a 13-item scale (baseline $\alpha = 0.64$; follow-up $\alpha = 0.78$). Sample items included "A reason I am physically active is because I enjoy being physically active; A reason I am physically active is because physical activity feels good" (0 = no; 1 = yes).
8. Fruit Self-Efficacy was assessed using a 12-item validated scale (baseline $\alpha = 0.63$; follow-up $\alpha = 0.76$).[56] Each item, "How sure are you that you can…?," asked about a different fruit intake behavior (0 = Not sure; 1 = Sure), such as "eat 1 portion of fruit for dinner at home at least one time" and "eat 1 portion of fruit for snack at home at least 4 days a week."
9. Vegetable Self-Efficacy was assessed using an eight-item validated scale (baseline $\alpha = 0.74$; follow-up $\alpha = 0.77$).[56] Each item, "How sure are you that you can…?," asked about a different vegetable intake behavior (0 = Not sure; 1 = Sure), such as "eat 1 portion of a vegetable at lunch at least one time on a school day" and "eat 3 portions of vegetables at least 4 days a week."
10. Water Self-Efficacy was assessed using a five-item validated scale (baseline $\alpha = 0.67$; follow-up $\alpha = 0.77$).[56] Each item, "How sure are you that you can…?," asked about a different water intake behavior (0 = Not sure; 1 = Sure), such as "drink 4 glasses of water at least one day" and "drink only water whenever you are thirsty for at least one day."
11. PA Self-Efficacy was assessed using a 12-item scale (baseline $\alpha = 0.78$; follow-up $\alpha = 0.83$).[61] The items were summed. Sample items included "I enjoy being physically active; Physical activity feels good" (0 = Not sure; 1 = Sure).

Social desirability. Social desirability was assessed at baseline using a nine-item scale[62] with good internal consistency ($\alpha = 0.81$), and items were summed. Sample items included "I never say things I shouldn't; I tell the truth every single time" (0 = Never true of me; 1 = Not sure; 2 = Sometimes true of me; 3 = Always true of me).

### *Statistical analysis*

To test H1—that African-American and Hispanic players will be more immersed in "Diab" than Caucasian players—one-way analyses of variance (ANOVA) were conducted on the immersion score among 87 children (African-American, Caucasian, and Hispanic; the 10 children of other racial and ethnic groups were excluded from this analysis because of the small number). A follow-up analysis of covariance (ANCOVA) was conducted on these children while controlling for social desirability. Tukey's post hoc comparison was used to detect group differences in immersion. Paired sample $t$ tests were conducted to detect if "Diab" had improved any of the health outcomes. To test H2—that increased levels of immersion will be related to more positive health outcomes—partial correlations were calculated between the immersion scale and change scores (Post-test minus Baseline) while controlling for Social Desirability among all available treatment group children. To investigate the two research questions, ANCOVAs with ethnic groups as a fixed effect were first performed to detect whether there would be any ethnic differences among the change scores of health outcome while controlling for social desirability. The immersion score was then added to the ANCOVAs as an additional control.

## Results and Hypotheses Testing

Of the 103 intervention group children, 97 completed the 18-item immersion scale. Their average age was 10.8 years ($SD = 0.8$), and 44% were female. The group was multiethnic (27% African-American, 35% Caucasian, 25% Hispanic, and 10% of other ethnic background). Table 1 provides descriptive statistics for participants. Those with missing data on the immersion scale ($n = 6$) were excluded from the analyses. There were no demographic differences between the 97 participants who were included and the six who were excluded (data not shown).

Although the immersion score showed a wide distribution, ranging between 18 and 54, the average immersion score was 40.8 ($SD = 8.2$), to the right of center (36) of the range of possible scores (18–54). The Skewness (–0.461) and Kurtosis (–0.724) statistics for the immersion score were less than the absolute value of 1. The Kolmogorov–Smirnov test also indicated that there is insufficient evidence ($P = 0.093$) to show that the distribution of immersion is not normal. Children were, therefore, on average immersed in "Diab." The mean immersion score of the 87 children ($M = 40.9$, $SD = 8.1$) from the dominant ethnic groups (i.e., African-American, Caucasian, and Hispanic) did not differ significantly that of from the excluded 10. Immersion differed significantly across the three ethnic groups: $F(2,84) = 9.8$, $P < 0.01$, partial $\eta^2 = 0.19$. The Caucasian players ($M = 36.5$, $SD = 1.3$) were significantly less immersed than the African-American players ($M = 44.0$, $SD = 1.4$) and the Hispanic players ($M = 43.4$, $SD = 1.5$) ($P = 0.01$). The difference between African-Americans and Hispanic players was not statistically significant. Because the immersion score was significantly correlated with social desirability ($r = 0.24$, $n = 87$, $P = 0.023$), ANCOVA was performed while controlling for social desirability and yielded similar results. Thus, H1 was supported.

FV Preference, Fruit Self-Efficacy, Vegetable Self-Efficacy, and PA Self-Efficacy significantly improved ($P$ values < 0.05),

Table 1. Participant Characteristics

| *Characteristic* | n *(%)* |
|---|---|
| Age (years) | |
| 10 | 41 (42.3) |
| 11 | 32 (33) |
| 12 | 24 (24.7) |
| Gender | |
| Female | 43 (44.3) |
| Male | 54 (55.7) |
| Race/ethnicity | |
| African-American | 27 (27.8) |
| Caucasian | 35 (36.1) |
| Hispanic | 25 (25.8) |
| Other | 10 (10.3) |
| Household income | |
| Less than $40,000 | 20 (21.3) |
| $40,000–$69,000 | 19 (20.2) |
| $70,000 or more | 55 (58.5) |
| Highest household education | |
| Some college or less | 29 (29.9) |
| College degree or more | 68 (70.1) |

Table 2. Baseline and Post-Test Key Health Outcomes from 97 Study Participants

| *Key health outcome* | *Baseline* | *Follow-up* | P |
|---|---|---|---|
| Fruit/Vegetables Preference | 68.36 (13.53) | 71.54 (15.49) | 0.001 |
| Water Preference | 2.64 (.65) | 2.59 (.72) | NS |
| Physical Activity Preference | 58.84 (10.69) | 59.12 (12.32) | NS |
| Intrinsic Motivation for Fruit | 5.89 (1.94) | 6.15 (2.18) | NS |
| Intrinsic Motivation for Vegetable | 3.76 (1.82) | 3.73 (1.94) | NS |
| Intrinsic Motivation for Water | 5.19 (1.95) | 5.51 (1.91) | 0.074 |
| Intrinsic Motivation for Physical Activity | 6.10 (2.37) | 6.30 (2.77) | NS |
| Fruit Self-Efficacy | 9.49 (2.12) | 10.39 (2.29) | 0.001 |
| Vegetable Self-Efficacy | 4.69 (2.24) | 5.32 (2.22) | 0.004 |
| Water Self-Efficacy | 3.56 (1.39) | 3.69 (1.54) | NS |
| Physical Activity Self-Efficacy | 8.39 (2.81) | 9.00 (2.87) | 0.012 |

Data are mean (*SD*) values.
NS, not significant.

and Intrinsic Motivation for Water marginally improved ($P = 0.07$) from the baseline (Table 2). There were no differences in these variables among the three ethnic groups at the baseline level ($P$ values $> 0.10$) except for Vegetable Self-Efficacy (Hispanic children scored significantly lower than Caucasian and African-American children, $P < 0.05$). Correlations between immersion and FV Preference ($r = 0.27$), Intrinsic Motivation for Water ($r = 0.29$), Vegetable Self-Efficacy ($r = 0.24$), and PA Self-Efficacy ($r = 0.32$) were significant (Table 3), and most were approaching moderate by Cohen's threshold for correlation (small, 0.1; moderate, 0.3; large, 0.5).[63] Thus, H2 was partially supported.

To answer the two research questions, ANCOVAs were first performed on change scores of FV Preference, Fruit Self-Efficacy, Vegetable Self-Efficacy, and PA Self-Efficacy among the 87 children with social desirability as a control variable. African-American children's Intrinsic Motivation for Water ($M = 0.8$, $SD = 2.0$) improved more than that of Caucasian children ($M = -0.2$, $SD = 1.8$) ($P = 0.024$). Hispanic children's PA Self-Efficacy ($M = 1.4$, $SD = 2.3$) improved more than that of Caucasian children ($M = -0.03$, $SD = 2.1$) ($P = 0.025$) (positive means indicate improvement). When immersion scores were added as an additional control, the immersion scores ($P$ values $< 0.05$) accounted for participants' ethnic differences ($P$ values $> 0.27$) for both change scores in Intrinsic Motivation for Water and PA Self-Efficacy.

## Discussion

"Diab" was perceived to be an immersive game by most children, especially by those of African-American and Hispanic descent. This may be partly attributed to the extensive formative work with youth in the preparation stage, especially among those belonging to these two ethnic groups.[41] With comprehensive data collected from this population, the development team integrated children's input into a meaningful game narrative, created appealing characters and plot, and managed to maintain children's interest with successful cliff-hangers after each of the game sessions (as indicated by a retention rate exceeding 90%).

Although the exact cause for the higher immersion scores for African-American and Hispanic children than that of Caucasian children cannot be determined in this study, it may be related to the similar appearance between the protagonist and the African-American and Hispanic children. Similar characters may help to increase the level of perceived immersion within the players, especially among the ethnic minorities. Aside from the similarity issues, the fact that the main character possessed both African-American and Hispanic phenotypic features could have become more salient to children of these race and ethnic groups given the usual overrepresentation of Caucasian characters in games.[64]

Immersion was positively related to several outcomes related to FV and water intake, as well as PA, suggesting more immersive health games will be more influential on players' health attitudes and preferences. More important is that further analysis indicated that immersion could account for the ethnic differences in the health outcomes. These results emphasize the potential importance of increasing a health videogame's influence by creating immersive narratives with characters that appear similar to the target population.

Videogame play typically involves a multitude of cognitive and affective resources,[65] and this is especially true of

Table 3. Partial Correlation Controlling for Social Desirability for 84 Study Participants

| | *"Diab" Immersion* | *Fruit/ Vegetables Preference* | *Intrinsic Motivation for Water* | *Vegetable Self-Efficacy* | *Physical Activity Self-Efficacy* |
|---|---|---|---|---|---|
| "Diab" Immersion | 1 | — | — | — | — |
| Fruit/Vegetables Preference | 0.27 $P = 0.014$ | 1 | — | — | — |
| Intrinsic Motivation for Water | 0.29 $P = 0.006$ | NS | 1 | — | — |
| Vegetable Self-Efficacy | 0.24 $P = 0.027$ | NS | NS | 1 | — |
| Physical Activity Self-Efficacy | 0.32 $P = 0.003$ | NS | 0.22 $P = 0.04$ | 0.38 $P < 0.001$ | 1 |

"Diab," "Escape from Diabetes" videogame; NS, not significant.

games involving narratives. Children's cognitive abilities are still under development, and it is highly likely that some young players may find a videogame to be difficult or taxing. Because taking the perspective of similar characters has been found to require less effort and adjustment than dissimilar others,[66] it is possible that the ethnic phenotypic similarities between the main character, Deejay, and African-American and Hispanic players helped to make "Diab" less cognitively demanding for these players, whose mental resources were freed up to process health-related information.

The limitations of this study include the small sample, the marginal reliabilities for some of the scales, and the concentration of participants in one geographic region of the country. Mediation analyses of the role of immersion were precluded because of a lack of statistical power, but association testing between the immersion score and the dependent health outcomes in this study is a first step to establish mediation[67] and should inform the identification of mediators for future health intervention. Immersion may be a mediating mechanism for relations between health videogames and health outcomes. As the first study examining the issues of videogame immersion and its health impact, promising results were obtained, although clearly not definitive. Future studies need to address potential mechanisms during this process by enrolling more participants and conducting more controlled experimental studies. More studies should also explore potential means of maximizing immersion, such as enabling each individual player to customize characters to realize health videogames' potential for childhood obesity prevention. Additional comparable health games featuring main characters with phenotypic characteristics from racial and ethnic groups other than African-Americans and Hispanics could help to more thoroughly investigate whether there is any racial or ethnic difference in videogame immersion.

## Conclusion

"Diab" was designed as a narrative videogame for health specifically designed to appeal to players of different racial and ethnic backgrounds. The level of immersion was high among African-American and Hispanic players. Children's videogame immersion was related to several health outcomes. Effectively embedding characters with similar phenotypic features to the target population in interactive health videogame narratives could be especially important to reach and influence children for obesity prevention.

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