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To Pause With a Cliffhanger or a Temporary Closure? The Differential Impact of Serial Versus Episodic Narratives on Children's Physical Activity Behaviors

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Abstract

Research has supported the effectiveness of narratives for promoting health behavior, but different narrative presentation formats (serial vs. episodic) have seldom been compared. Suspense theories suggest that serial narratives, which do not provide a full resolution at the end of an episode, may create higher motivation for continued engagement with a story. Forty-four 8 to 12-year-old children were randomly assigned to watch an animation series designed for an existing active video game in which the plot was delivered either continuously across multiple episodes (serial) or in multiple yet relatively independent self-contained episodes (episodic). Controlling for social desirability, children who watched the serial narrative had significantly more moderate to vigorous physical activity (MVPA) and step counts while the episodic group's gameplay duration decreased, especially during later visits. There was no difference in self-reported narrative immersion or physical activity intention. Serial narratives can result in more time spent in MVPA behaviors than episodic narratives.

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Narratives are pervasive in the mediascape, and many of these narratives have multiple episodes (such as a television series). Beyond specific genres and characters, the structure of a narrative series is crucial for continued narrative engagement (Knobloch et al., 2004). There are two main distinctive types of extended narratives: serial (which tells a story in continuous segments and episodes often end with a cliffhanger) versus episodic (which relies more on stand-alone episodes that provide temporary closure to the conflict at the end of each episode) (Mittell, 2015). Both presentation formats can be used to convey the same general story plot. In one, each episode builds upon previous episodes and sets up future episodes, while the other uses the same characters and settings but presents more self-contained stories. Although the two forms, serial versus episodic plot, have been examined conceptually in film and TV research (Creeber, 2004; Konigsberg, 1997; Mittell, 2006), no empirical studies of their impacts, or assessments of their behavioral effects, have been conducted.

This study is intended to fill this gap by examining the differential behavioral effects in the context of active video gaming among children as a result of exposure to these two different types of narrative presentations across repeated play sessions. We examined whether children engage in more physical activity across sessions when an active game is paired with serial versus episodic narratives. We aim to provide a more nuanced theoretical and empirical foundation to further our understanding of the role of narrative presentation on children's narrative perception and actual behaviors.

Background

Narrative Presentation: Serial Versus Episodic Stories and Their Potential Impact

A simple definition describes a narrative as two or more events connected or presented in a certain order (Rimmon-Kenan, 2002). A more comprehensive definition considers a narrative as "any cohesive and coherent story with an identifiable beginning, middle, and end that provides information about the scene, characters, and conflict, raises unanswered questions or unresolved conflict; and provides resolution" (Hinyard & Kreuter, 2007, p. 778). At its core, a narrative is about the "telling of someone's experience about something" (Dahlstrom, 2021, p. 2).

A large body of research suggests that narratives can influence cognition, affect, and behavior through transportation into a narrative world (cognitive, emotional, and mental imagery engagement). This type of narrative immersion enables the suspension

of disbelief, makes narratives seem more like a vivid personal experience, and creates a deep affection for the characters (Green & Brock, 2000; see van Laer et al., 2014, for a meta-analytic review). Narratives have demonstrated motivational effects for various types of health behavior change (e.g., Moyer-Gusé & Nabi, 2010; Murphy et al., 2015; Zhou et al., 2020). However, many of these studies used narratives that can be read or watched in a single setting, and in most studies, narratives were compared against controls involving either non-narrative conditions (e.g., rhetorical claims or statistics) or no-message conditions. Entertainment-education research has examined the effects of extended narrative engagement (for example, telenovelas or serial radio dramas; Singhal & Rogers, 2012), but this work has not explicitly considered the structure of the narrative. In particular, serial versus episodic narratives may have different effects on viewers' continued engagement and narrative-related outcomes.

In real-life film and TV production, the differentiation of serial versus episodic is not necessarily dichotomous. For example, Schlütz (2016) identified four forms of narrative structure in television [anthology series (i.e., loosely connected episodes bound by a theme, e.g., *ToonHeads*), episodic series (i.e., every episode is more or less independent of each other, e.g., *The Simpsons*), continuous serials (i.e., each episode follows each other and moves the story to an end, e.g., *Lost*), and hybrid forms (i.e., shows that oscillate between episodic and continuous format, e.g., *ER*)]. These forms can be laid out on a spectrum with one end being episodic (e.g., anthology and episodic series) and the other being continuous serials, with the hybrid forms in between. In this study, we will only test the continuous serials (or serial narrative) versus the episodic series (episodic narrative) while excluding the extreme episodic (e.g. anthology series) and the in-between (e.g., hybrid forms).

In a serial narrative, each episode forms a continuous unit of a larger story and often ends with a cliffhanger. A cliffhanger refers to unresolved tensions in a story created to motivate audiences to come back to the next episode (Baranowski et al., 2008; Wirz et al., 2022). A serial plot can serve as "an invitation to viewer involvement and engagement" (Schlütz, 2016). There are several theoretical reasons why serial narratives may lead to longer-term engagement, including the emotional feelings of suspense and the cognitive desire for narrative completion or cognitive closure.

First, the serial plot helps to establish suspense, an important motivational force (Dolan, 1995; Vorderer et al., 2013; Vorderer & Knobloch, 2000). Suspense occurs when individuals have a positive disposition toward a character and hope for a good outcome for the character (but fear a bad outcome; Zillmann, 1996). It creates a state of arousal, and a feeling of relief when the suspense is resolved. Suspense has been associated with extended narrative engagement. For example, seeking out and feeling suspense was associated with binge-watching (Rubenking & Bracken, 2018), in which audiences watch multiple episodes of a series in a single sitting.

Second, narrative completion, or people's conscious effort to progress through a narrative (often a serial narrative) to learn what is next (Porter et al., 2002), has been an additional factor distinct from narrative transportation in motivating binge-watching (Pittman & Steiner, 2019). The desire for completion appears to be a more general

cognitive tendency. For example, research on the Zeigarnik effect (Mäntylä & Sgaramella, 1997) indicates that people tend to remember interrupted things better and with greater frequency than they remember things that are complete. Similarly, when a story is started but not completed, the brain may keep the story information and push it into the unconscious mind until the story is finished.

Motivation to complete an engaging narrative can go above and beyond binge-watching to influence other behaviors, including exercise. For example, temptation bundling, or pairing a pleasurable narrative engagement (e.g., enjoying their favorite audiobook at the gym) with a healthy behavior (e.g., exercise in the gym) among adults has been found to significantly boost their gym visits (Kirgios et al., 2020; Milkman et al., 2014). Although this line of work provides initial evidence about the long-term motivation potential of narratives, the narratives in that work were not directly related to the type of exercise. Rather, the narratives were used as an aid to self-control by pairing an enjoyable activity (listening to a story) with a less enjoyable one (exercising). These studies also did not investigate the narrative structure. In the current research, we suggest that higher continued motivation to engage with the narrative may lead to more physical activity when the narrative is paired with an active video game.

The research reviewed above suggests advantages for serial narratives for both continued engagement with an extended narrative and for outcomes related to the narrative. In contrast to serial plots, episodic plots, which comprise short, complete narratives that loosely arc sub-stories with the same characters and settings (Baranowski et al., 2008), also have their advantages. For example, programs such as *Sesame Street* and *Curious George* are typically episodic, dramatic stories involving a group of characters and do not necessarily require audiences' constant recollection of the previous episode. Each character has their own story, which, from episode to episode, relates to those of others in unpredictable ways. Episodic plots may work primarily to maintain attention when children like and identify with the characters. This type of narrative presentation can help to sustain behavioral change and provide maintenance messages in multiple sessions (Baranowski et al., 2008). A possible benefit of episodic narratives is that children may experience the relief of finding out what happened during one episode, and this satisfaction could increase their liking for the story, or the game associated with the story.

Differences in self-regulatory abilities may suggest differences between children and adults in narrative preferences. First, when compared to adults, children's relative lack of effective self-regulation (Howse et al., 2003; Lipps & Deysher, 1986) may predispose them to prefer the complete narrative in one session instead of waiting to see how the story would unfold over a longer interval. It is possible that the cliffhanger style in serial narratives may impede the desired narrative-related behavior (e.g., physical activity) in the longer term because children may be so interested in uncertainty reduction (or frustrated by the continued uncertainty) that they become unable to live with suspense and lose interest after a few episodes before the whole show ends.

Indeed, a study of fourth-grade children identified the reinforcing and incentive properties of uncertainty reduction (Feldstein & Witryol, 1971). Children were willing

to forgo larger rewards to reduce uncertainty more quickly. Although prior work on uncertainty reduction in children has not used narrative contexts, this work could suggest that children may show greater enjoyment or liking for stories that provide more immediate uncertainty reduction (e.g., greater plot resolution at the end of each episode), which may translate to more behavior change.

However, although there is some possibility that children may prefer the immediate resolution of an episodic story, the bulk of the theoretical and empirical work suggests that serial narratives will be more effective. While the episodic narrative might temporarily provide uncertainty reduction and relief among children, we expect that the serial narrative may still be equally, if not more effective in terms of persuasive effect (e.g., attitude, and actual behavior change) over a longer term. To answer this question, we explored the serial versus episodic effect in the context of active video games to combat childhood obesity.

Child Obesity, Physical Activity, and Active Video Games

Over 35% of U.S. children are overweight or obese (National Center for Chronic Disease Prevention and Health Promotion, 2019). Childhood obesity tracks into adulthood and has many negative influences on children's development (Danaei et al., 2009; Janssen et al., 2004; Li et al., 2008; Liang et al., 2014; National Cancer Institute, 2017; National Institute of Diabetes and Digestive and Kidney Diseases, 2018; Swallen et al., 2005). The U.S. childhood obesity rate is increasing among all age groups (Skinner et al., 2018) and the COVID-19 pandemic exacerbated that (Nagata et al., 2020; Woolford et al., 2021). While the U.S. Physical Activity (PA) guidelines recommend that children participate in at least 60 min of daily moderate to vigorous PA (MVPA) (U.S. Department of Health and Human Services, 2018), few children meet this guideline (National Physical Activity Plan Alliance, 2018), with sedentary screen time identified as one of the best-documented causes of childhood obesity (Robinson et al., 2017).

Physical activity (PA), a vital factor for children's psychological, physical, and cognitive health, is critical to childhood obesity prevention (Hills et al., 2011; Janssen & LeBlanc, 2010; Katzmarzyk et al., 2015; Romero-Pérez et al., 2020). However, PA dramatically decreases between childhood and adolescence, and the decline continues with age (Troiano et al., 2008). Most PA interventions among children, however, have had no effect on PA (Nooijen et al., 2017). Significant challenges were identified including lack of motivation and limited access to places to be physically active (National Physical Activity Plan Alliance, 2016). Most home-, school-, or community-based PA interventions failed to achieve sufficient engagement (Metcalf et al., 2012; Thivel et al., 2018).

Innovative alternatives that capture children's interests and motivate behavior change are needed. The intersection of active video games (AVGs) and narratives offers one such promising venue. AVGs are video games that require the user's physical movement to play (Bailey & McInnis, 2011). One example is *Beat Saber* (Beat Games, 2018), a virtual reality game in which players swing their arms to cut

incoming blocks and dodge obstacles. Other examples include games designed for the Wii, Nintendo Switch, or Xbox Kinect consoles that require players to run, jump, duck, or dance to achieve the goals of the game (e.g., *Nintendo Switch Sports; Ring Fit Adventure; Just Dance*). These types of games can serve as an effective, enjoyable, and accessible way to increase PA (Gao et al., 2015; Hwang et al., 2019; Williams & Ayres, 2020). Indeed, the strongest evidence for behavior change via gamification has been found in PA promotion (Johnson et al., 2016). According to multiple systematic reviews, AVG use significantly improved the duration of vigorous PA among children (Gao & Chen, 2014; Lu et al., 2013) with a small to medium effect on BMI reduction (van't Riet et al., 2014).

Narratives for PA Promotion via AVGs

However, a significant challenge for AVGs is maintaining player engagement. Despite their fun and engaging attributes (Benzing & Schmidt, 2018), AVGs are less likely to be played for long periods of time than sedentary games (Graves et al., 2010; Lyons et al., 2011). Most AVGs simply provide players with game instructions and let them explore the rest of the game. The key motivational factors are simply more levels with higher points and badges for player progression and can potentially be repetitive over time as they do not offer qualitatively new types of feedback. Player interest may plateau after a relatively short time.

Although narratives appear in around 20% of all health games (Lu & Kharrazi, 2018), few AVGs capable of achieving more moderate to vigorous physical activity have been designed with them (Lu et al., 2013). One reason for the diminished PA engagement may be that AVGs rarely incorporate storylines (Lu & Kharrazi, 2018). Integrating AVGS with narratives can be a promising solution. That is, placing the game activity (e.g., running and dodging) in the context of a broader storyline (e.g., escaping from or defeating a villain) should help increase player motivation and result in better PA outcomes in terms of higher intensity and/or longer engagement (Lu, 2015).

Evidence for the Benefits of Combining Narratives With AVGs

An important source of gameplay motivation and experience is narrative involvement (Bateman, 2006; Yee, 2016). Adding a narrative to existing AVGs has been shown to boost players' motivation and PA (Lu, Baranowski, et al., 2016; Lu et al., 2019, 2023; Sousa et al., 2020). However, not all narratives are equally motivational. In previous work, we found that narratives with interesting plots, such as cliffhangers, and supernatural characters could promote PA behavior among 8 to 12-year-old children (Lu, Buday, et al., 2016). We have also found across all race, sex, and weight groups, children aged 8 to 12 years old tended to like fantasy genres with a dystopian futuristic setting (Lu et al., 2019), which is consistent with science fiction being the most popular reading topic among children (Sturm, 2003).

Several recent studies investigated the effect of adding narratives to AVGs to induce PA behavior across multiple gaming platforms, with promising results (Lu, Baranowski,

et al., 2016; Hwang & Lu, 2018; Lu et al., 2023). The AVGs used in those studies were either endorsed by American Heart Association for stimulating beneficial physical activities or empirically tested among the target population to induce MVPA (American Heart Association and Nintendo, 2010; Hwang et al., 2019; Sousa et al., 2022).

In previous work, we created a 3-min child-friendly narrative animation for a pretested AVG and interspersed the animation into the AVG, thus creating a narrative and a no-narrative version of the same AVG. Forty children with overweight or obesity between 8 and 12 years of age (50% male) were recruited to a lab simulating a modern-day living room and randomized to either of the conditions. Children in the narrative group had 40% more steps than those who played the original no-narrative version of the AVG (Lu, Baranowski, et al., 2016). Similar patterns were replicated among college students. The narrative increased MVPA by 58% (Hwang & Lu, 2018) when compared to the condition without the narrative.

To rule out an alternative explanation of the video addition effect, another study compared the motivational effect between two animated videos (one a narrative and the other a non-narrative documentary on the benefit of physical activities) of comparable length and found similar superior effects for narrative, which produced 147% more MVPA than the non-narrative documentary animation among 8 to 12-year-olds. This effect was mediated by narrative immersion (Sousa et al., 2020).

For the current study, to ensure that narratives were engaging and could be integrated seamlessly into the AVGs, extensive interviews were conducted to ensure that the stories were appealing and encouraged the audience to continue playing the AVGs (Lu et al., 2019). Positive moral characters, spectacular deeds, compelling plots, superpowers, and engaging cliffhangers have been found to be story elements that help increase PA motivation among children (Lu, Buday, et al., 2016). We also validated that the AVG used in this study was capable of inducing MVPA (Hwang et al., 2019).

The Current Study

How should a narrative developed for an AVG be designed to motivate children to "continue" playing the game and engage in MVPA? Is it better to use a serial (i.e., little-by-little, in a piecemeal format consisting of several individual linear episodes) or an episodic (i.e., loosely connected mini-stories related by the same characters/settings) form? This question has theoretical and practical implications for media psychologists, game designers, and health researchers. To our knowledge, despite the wide popularity of serial and episodic plots across the mediascape, neither the persuasive effects nor the behavioral consequences of these two narrative approaches have been compared, let alone among 8 to 12-year children.

Without intervention, 8 to 12-year-old children who are obese are more likely to become obese adults (Whitaker et al., 1997). Focusing on a high-risk population is crucial (Foster et al., 2010) since interventions have also been found to be effective primarily among people who are already overweight or obese (McMurray et al., 2000). The effect of implementing narrative in AVGs should be amplified among higher-risk groups (Ledoux et al., 2011). Additionally, children younger than eight are cognitively

limited in answering survey questionnaires in general (Borgers et al., 2000), whereas children older than 12 have entered early adolescence and have been through multiple mental, physical, and social changes and may require a different set of intervention strategies (Centers for Disease Control and Prevention, 2010).

Since most home-, school-, or community-based PA interventions have failed (Metcalf et al., 2012; Thivel et al., 2018), identification of engaging and child-friendly PA interventions is critical. Relevant theoretical perspectives related to the two types of narratives suggest that each might have its pros and cons in terms of outcomes (including MVPA behavior, narrative immersion, and PA motivation). Therefore, the current study investigated the difference between the two narrative presentations in terms of their effects over time and the extent to which these effects were influenced by narrative immersion.

Although both narrative types may have benefits, suspense and cognitive completion theories suggest that serial narratives might be more effective for long-term engagement. Due to the temporary relief at the end of each episode under the episodic condition, AVG play behavior could potentially be reduced because the temporary satisfaction gained from the episode may not provide the same strength of motivation when compared to a serial plot. On the other hand, in a serial plot, multiple episodes create a stronger narrative arc with potentially higher mental and emotional stimulation over the course of the narrative series.

Therefore, we tested the following hypotheses:

H1: AVGs with serial plots will induce more MVPA in children than AVGs with episodic plots;
H2: AVGs with serial plots will result in higher narrative immersion in children than AVGs with episodic plots;
H3: AVGs with serial plots will result in greater PA motivation in children than AVGs with episodic plots.
H4: The effect of serial plots on PA and PA motivation will be mediated by narrative immersion.

Methods

Recruitment

We partnered with a Greater Boston elementary school to recruit 8- to 12-year-old children of various ethnic backgrounds from 10 third-to-sixth Grade classes, specifically from their after-school programs. Parents received consent and assent forms along with a demographic questionnaire that requested their children's demographic characteristics (age, race, and sex), height, weight, handedness, and their socioeconomic status (SES; i.e., the highest education level of parents, annual household income). Parents were asked if their child had ever been diagnosed with any attentional or neurological disorder, if they were taking any medications affecting their central nervous system that might interfere with study assessments, if they had any mobility issues, and if they had any prior experience playing the AVGs used in this study. We used the data to see if the

children fit the requirements for inclusion (parents needed to answer "no" to all questions). The study was authorized by the Northeastern University Institutional Review Board. All participants gave assent, and their parents gave their consent.

Procedures

Data collection occurred over four visits in multiple classrooms during the participating elementary school's after-school program from September 2017 to June 2018. Each visit was at least 5 days apart from another visit. Each child completed this study over an average of 3 weeks. At each visit, we collected their comments about the narrative viewing and the objectively measured physical activity resulting from narrative viewing.

Prior to each visit, research assistants (RAs) set up an Xbox console connected to a smartboard in each classroom. As part of our experimental assessment procedures, for at least 2 hr before the study, children were told not to eat or drink anything other than water. Once they arrived, we provided them with an orientation to study procedures, assessed their height and weight, and calculated their Body Mass Index (BMI) percentile, which is a more appropriate instrument than BMI alone for child obesity research (Rosner et al., 1998). We then showed them three episodes of either a serial or episodic animation interspersed into the AVG sessions via a smart board and asked each child to play as much as they liked. To control for the novelty effect, the first session was for familiarization, which we did not analyze because some children took longer to become familiar with the AVG system than others. Between the animation viewings, the RAs showed children how to play each of the mini-games in the AVG and let them try out the game while wearing a heart rate monitor and accelerometer. The next three sessions were conducted using the identical procedure except there was no instruction on how to play the AVG. Children were given as much time as they would like to play the AVG. Since we are primarily interested in children's self-motivated play and exercise behavior, our data analysis focused on their performance from Visits 2 through 4.

Serial Versus Episodic Narrative Development

The animation we presented to children was one of two 12-episode Sci-Fi animation series in which we varied the style of narrative delivery (serial vs. episodic). A professional production studio created the animation series, *Ataraxia*, which incorporated AVGs in its story. *Ataraxia* is set in a dystopian future world in which a twin brother and sister, who can remove pain from others, are kidnapped by an evil king in order to create an invincible army. Throughout the story, the player character, who grows up with the twins, begins to develop different superpowers through exergaming and must train to master these powers in order to help save the twins and Ataraxia from villains. The serial plot version of the story presents the story in a chronological fashion, with each episode based on the previous one, thus tempting the audience to move on to the next, until the narrative climax when the player

character and the twins confront the evil king. The episodic plot has a similar beginning and end, but the characters introduced in each episode resolve their dramatic conflict within that episode.

Active Video Game and Game Console

We used an Xbox One console (Microsoft Inc., Redmond, WA, USA) with a Microsoft Kinect camera motion tracking sensor. The sensor allows a user to project their body onto the screen and track their body's position during gameplay. We chose *Shape Up* (Ubisoft, Montreal, Canada), a fitness-based exergame composed of a number of mini-games. We used five of its mini-games [*Piano Step* (side-stepping), *Stunt Run* (running, jumping), *Squat Me to the Moon* (squatting), *Volcano Skate* (skating), and *Waterfall Jump* (jumping, surfing)] because they primarily demanded lower-limb movements capable of eliciting higher levels of energy expenditure at a moderate or vigorous intensity (Hwang et al., 2019). The order in which the mini-games were played was random, with each game lasting around 90 s and a 15-s gap between games to switch to the next game. A participant could pause the game or set their own pace, which was similar to the types of movements that occur when they engage in school-based physical activities (Mullins et al., 2019).

Anthropometric Measurement

We measured height (to the nearest 0.1 cm) using a ShorrBoard (Weight and Measure, LLC, Olney, MD, USA) and weight (to the nearest 0.1 kg) using a SECA scale (SECA Inc., Chino, CA, USA) and then computed BMI (kg/m^2). If more than a 0.2 cm or a 0.2 kg difference existed between the first two measurements, we took a third measurement. We also determined participants' BMI percentiles using the Centers for Disease Control and Prevention BMI-for-age growth charts (Kuczmarski, 2000).

Physical Activity, Heart Rate, Exertion, and Play Duration Assessments

On each participant, we attached two tri-axial GT9X accelerometers (ActiGraph LLC, Pensacola, FL, USA): one was placed on their non-dominant wrist through a silicone wristband; the other was placed at the anterior axillary line of their non-dominant hip with a belt clip (Hwang et al., 2019). Using activity counts based on established cut-off points (Butte et al., 2014), we computed the time spent in MVPA. We also used a soft textile strap to attach a Polar H7 Bluetooth heart rate sensor (Polar H7, Polar Electro Inc., Lake Success, NY) to the participant's chest to detect continuous heart rate during the testing sessions and communicate signals to the wrist-worn GT9X accelerometer via Bluetooth. We used the GT9x to collect heart rate data over 10-s epochs, as previously used for AVG assessments involving intermittent physical activities (Hwang et al., 2018). The values were converted to beats per min (bpm). Before and after each gaming session, we measured the participants' heart rates and rating of perceived exertion (RPE, category range: 0–10) (Robertson et al., 2000). Because

variations in heart rate during gameplay may be linked to weight (Hwang et al., 2019), accelerometry-based counts and volume were prioritized for determining exercise intensity. Step counts were calculated using both GT9X accelerometers. In addition, RAs documented the duration of children's game play using a stopwatch.

Additional Questionnaires and Scales

After watching the daily animation episodes, children answered questionnaires that included demographics, narrative immersion (Lu et al., 2012), PA motivation (Kendzierski & DeCarlo, 1991), and social desirability (Reynolds & Paget, 1983).

Narrative Immersion. The narrative immersion questionnaire was modified from Green and Brock's (2000) narrative transportation scale, which has been widely used among adults to measure cognitive and affective engagement in a narrative. In previous work with children, we found that they understood the term "narrative immersion" better than "narrative transportation."

As a result, the narrative immersion (NI) scale (Lu et al., 2012) was adapted for children's understanding by revising the original 11-item narrative transportation scale (Green & Brock, 2000). Because the original scale focused on transportation via textual media, one of the original items ("I had a vivid image of [character name]") was removed. Consequently, the narrative immersion scale captures all of the original's essential aspects for assessing children's reactions to visual narrative media (Lu et al., 2012). The remaining ten items have previously been tested multiple times among children of the same age group (Lu, Baranowski, et al., 2016; Sousa et al., 2020). The terminology from the original narrative transportation scale (e.g., I could picture myself in the scene of the events described in the narrative) was slightly modified in the NI scale (e.g., I could picture myself in the story) to ensure children's understanding.

We lowered the choice options from 7- to 5-points given the standard psychometric practice for children (Mellor & Moore, 2013), with 1 = disagree, 3 = neutral, and 5 = agree. Sample items for narrative immersion include "I wanted to find out how the story ended" and "I was completely involved in the story while watching it" (average Cronbach's $\alpha = .66$).

Physical Activity (PA) Motivation. PA motivation employed a 16-item binary option scale adapted from a validated exercise enjoyment scale (Kendzierski & DeCarlo, 1991). Sample questions include, "1 = PA makes me sad" vs. "5 = PA makes me happy;" and "1 = PA is no fun at all" vs. "5 = PA is a lot of fun" (Cronbach's $\alpha = .93$).

Social Desirability. A 9-item social desirability (SD) of response scale (Reynolds & Paget, 1983) was used to measure the perceived importance of social approval in children. We used this scale to control for demand characteristics to ensure that the children were not answering the questionnaires in a way to please our research team. Statements such as "I am always nice to everyone" and "I never say things I shouldn't"

were presented in an agree/disagree scale (1 = disagree, 3 = neutral, and 5 = agree) (Cronbach's $\alpha = .85$).

As children completed the questionnaires on paper, RAs collected them and checked each questionnaire's completion status. Children were thanked and brought back to their after-school activities. At the end of the fourth visit, each child was given a $100 gift card for their participation. The questionnaire responses were subsequently entered into an electronic database by the RAs. To ensure accuracy, all data entries were checked three times.

Statistical Analysis

We first assessed participant data for normality and homogeneity using Kolmogorov-Smirnov and Levene's tests, respectively. Categorical data were compared between groups using chi-square tests. The independent-sample *t*-test was used to compare the groups at baseline. Linear relationships were compared between groups with a one-way analysis of variance (ANOVA) and Tukey's post hoc test when necessary. Analyses of covariance (ANCOVA) models controlling for social desirability were applied to the main outcomes. The significance level was set at $p \leq .05$. The primary indicator of a significant difference was a significant visit × condition interaction effect. All analytical procedures were conducted using Statistical Software for the Social Sciences (IBM SPSS Version 28, Endicott, NY).

An *a priori* sample size was calculated in G*Power (Faul et al., 2009) to detect a significant difference between the two conditions over three visits with 95% power (1−beta) to detect a moderate effect size (partial eta square = .06). A sample size of 40 would provide a power of at least 94%.

Additionally, we ran multi-level Gaussian models of all the behavioral outcomes as well as self-report measures. Participants (level 1) were nested within visits (level 2) in these model specifications. Since children's levels of physical activity or tendency to engage in AVGs will predict their subsequent play behavior, we investigated each outcome's association with visit number (Visit 2–4) and condition (including their interaction) while controlling for baseline values (Visit 1) of each outcome and social desirability. The covariates in these models were chosen based on theoretical considerations and on corrected Akaike Information Criterion (AICc) and Bayesian Information Criterion (BIC) values.

Results

Demographic Information

We obtained data from 44 children. Their average age was 10.1 years ($SD = 1.30$) with 50% boys. The group was racially diverse, with 27.3% self-identifying as African American, 25% as mixed race, and 47.7% as White. No statistical differences were detected at baseline between the two experimental groups (Table 1) regarding their age, sex, racial composition, body composition, or social desirability.

Table 1. Age, Sex, Race, Body Composition, and Social Desirability of Participants in Both Conditions.

	Serial ($n = 22$)	Episodic ($n = 22$)	p Value
Age (year)	9.7 ± 1.4	10.5 ± 1.2	.07
Sex (girls/boys)	11/11	11/11	1.00
Race (n)			.57
African American	7	5	
Asian	0	0	
Hispanic/Latino	0	0	
Mixed	5	6	
White	10	11	
Height (cm)	145.3 ± 12.2	150.3 ± 10.1	.15
Weight (kg)	44.5 ± 15.2	53.6 ± 15.7	.06
BMI (kg/m^2)	21.4 ± 5.5	23.5 ± 5.8	.22
BMI percentile (%)	76.4 ± 24.4	80.8 ± 24.8	.56
Social desirability	3.3 ± 0.9	3.2 ± 0.8	.50

Note. Data expressed as mean ± standard deviation for all variables except for Race. BMI = body mass index.

The general linear model for game play duration showed a significant visit x condition interaction effect, with the episodic group's game play duration decreasing throughout the visits, consistent with H1. See Table 2 and Figure 1(a). The model for Heart Rate (HR) showed a significant visit effect, with an increasing HR throughout the visits, with the highest values in the last visit for both groups (Figure 1(b)).

The general linear model for MVPA measured with hip accelerometers also showed a significant visit × condition interaction effect, with an increasing difference between groups over visits (Table 2 and Figure 1(c)). The same significant interaction and pattern of differences was detected for MVPA measured with wrist accelerometers (Table 2 and Figure 1(d)), again supporting H1 (greater activity for the serial condition).

The two models for the step counts showed a similar significant visit x condition interaction effect with both hip and wrist accelerometers, with greater step counts in the serial condition (Table 2 and Figure 1(e) and (f)).

In multi-level models, as baseline controls, the Visit 1 values of all six behavioral outcomes (Game play, Heart Rate, MVPA hip, MVPA wrist, Step count hip, and Step count wrist) were positively and significantly associated with their respective outcomes during later visits (ps $< .01$ −.03). When all time points were considered for the overall totals of these variables, condition (serial vs. episodic) was not significant in any of the models (ps: .67–.89). However, compared to Visit 2, Visit 3 was positively related to longer playtime ($p < .01$) and both hip- ($p = .01$) and wrist-measured ($p = .04$) MVPA duration; and Visit 4 was associated with longer playtime ($p < .01$), lower heart rate ($p < .01$), longer hip- ($p = .03$) and wrist-measured ($p = .04$) MVPA duration, as well as higher hip- ($p = .03$) and wrist-measured ($p = .04$) step counts.

Table 2. Game Play Duration, Heart Rate, Along With MVPA and Step Count (Measured Via Hip and Wrist Accelerometers) During Each Follow Up Visit.

	Visit	Serial ($n = 22$)	Episodic ($n = 22$)	p Values
Game play (min)	2	11.8 ± 7.1	12.8 ± 7.9	Condition = .58
	3	11.3 ± 8.4	9.8 ± 5.8	**Visit = .02**
	4	11.7 ± 7.9	8.9 ± 5.1	**Interaction = .04**
HR (bpm)	2	139.3 ± 12.3	140.6 ± 14.3	Condition = .94
	3	144.9 ± 11.4	143.7 ± 13.0	**Visit < .01**
	4	148.2 ± 11.4	147.4 ± 14.6	Interaction = .71
MVPA hip (min)	2	7.2 ± 4.6	7.8 ± 5.0	Condition = .48
	3	7.5 ± 5.3	6.1 ± 3.6	Visit = .32
	4	8.2 ± 5.2	6.3 ± 3.2	**Interaction = .02**
MVPA wrist (min)	2	8.8 ± 6.4	8.9 ± 6.4	**Condition = .02**
	3	8.8 ± 6.8	8.1 ± 5.8	Visit = .34
	4	10.2 ± 7.0	8.7 ± 5.7	Interaction = .03
Step count hip	2	660.2 ± 507.3	708.4 ± 564.7	Condition = .45
	3	770.0 ± 572.7	650.0 ± 393.7	Visit = .82
	4	827.3 ± 607.7	569.0 ± 335.6	**Interaction = .01**
	2	651.5 ± 449.9	694.3 ± 556.2	Condition = .48
	3	703.5 ± 500.0	588.5 ± 361.2	Visit = .79
Step count wrist	4	754.0 ± 488.5	557.0 ± 338.0	**Interaction = .04**

Note. Data expressed as mean ± standard deviation. MVPA = moderate-to-vigorous physical activity; HR = heart rate. Bold entries in the p value column: $p < .05$.

In addition, when compared to the Episodic group, the Serial group had a significantly longer hip-measured MVPA duration ($p = .03$) during Visit 3 and significantly longer play duration ($p < .01$), longer hip- ($p = .01$) and wrist-measured ($p < .01$) MVPA duration, as well as more hip- ($p < .01$) and wrist-measured ($p < .01$) step counts during Visit 4, supporting H1. Social desirability was not significantly associated with any of the outcomes after adjusting for all other covariates in the respective models (ps: .07–.32). Additional analysis including BMI percentile and sex as covariates yielded similar results. Specific details about these models are available upon request. Thus, H1, which hypothesized that AVGs with serial plots would induce more MVPA in children than AVGs with episodic plots, was supported, especially during later Visits 3 and 4.

ANOVA and ANCOVA analyses showed no significant group differences or interaction effects for narrative immersion, PA motivation, or Rating of Perceived Exertion (RPE). See Table 3 for details. We conducted similar multilevel analyses for the three reported outcomes while controlling for Social Desirability. Similar to the mixed-ANOVA/ANCOVA analysis results, no differences were detected in the multi-level analysis except that the Visit 1 Narrative Immersion and RPE were significantly positive covariates as the baseline measures (ps $< .01$). Social desirability was not significantly associated with any of the outcomes after adjusting for all other covariates in

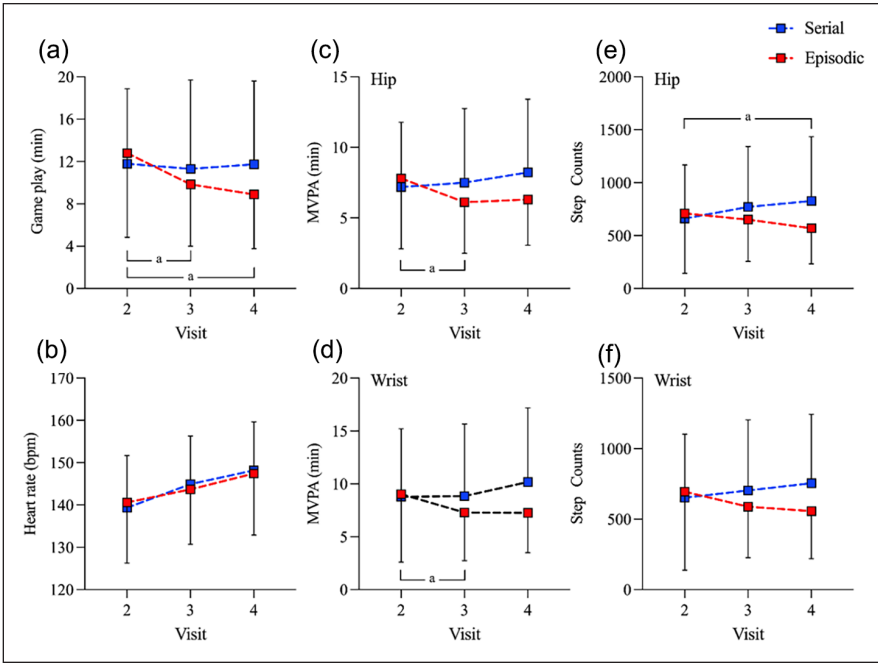

Figure 1. Game play duration (a), heart rate (b), along with MVPA (c & d) and Step Count (e & f) [measured via hip (c & e) and wrist (d & f) accelerometers] during each follow up visit across the Serial versus Episodic Conditions.
a: $p < .05$ post-hoc comparisons.

Table 3. Narrative Immersion, PA Motivation, and Rating of Perceived Exertion During Visits 2–4.

	Visit	Serial ($n = 22$)	Episodic ($n = 22$)	p values
Narrative immersion	2	3.7 ± 0.7	4.0 ± 0.6	Group = .11
	3	3.7 ± 0.7	4.0 ± 0.6	Visit = .78
	4	3.6 ± 0.8	3.8 ± 0.7	Interaction = 0.46
PA motivation	2	4.2 ± 0.7	4.3 ± 0.5	Group = .41
	3	4.2 ± 0.6	4.4 ± 0.8	Visit = .69
	4	4.3 ± 0.6	4.3 ± 1.0	Interaction = .66
Rating of perceived exertion	2	4.1 ± 2.9	4.4 ± 2.7	Group = .82
	3	3.9 ± 3.2	4.4 ± 2.9	Visit = .23
	4	3.7 ± 3.1	3.4 ± 2.3	Interaction = .52

Note. Data expressed as mean ± standard deviation. AVG = active video game.

the respective models (*p*s: .06–.19). Thus, neither H2 nor H3, both of which hypothesized that AVGs with serial plots would result in higher narrative immersion and PA motivation in children than AVGs with episodic plots, was supported. Additionally, because there were no differences between conditions in narrative immersion, narrative immersion could not serve as a mediator. H4 was not supported.

Discussion

This research examined the motivational effects of different types of extended narrative presentations (serial vs. episodic) and found that serial presentation has a stronger influence on behavior. Our study provides the first empirical insights into the effects of narrative plot presentation on exercise behavior, using a 12-episode animated series and measuring children's game play duration, heart rate, MVPA behavior (measured objectively via hip- and wrist-worn accelerometers), and subjectively measured narrative immersion, PA motivation, and rating of perceived exertion.

When a narrative was presented in a serial format, children who watched it engaged in significantly more MVPA than those who watched the same narrative presented episodically. This effect was supported using two objective behavioral measures with research-grade accelerometers. Although the overall heart rate increased over time for both narrative plot groups, children who watched the episodic narrative decreased their active video game play over time. These findings extend the traditional narrative health intervention design, which treats narrative as the sole independent variable (McQueen et al., 2011; Moyer-Gusé & Nabi, 2010; Murphy et al., 2015). Our work has also expanded the understanding of the narrative impact on the recipients' actual health behavior using a longitudinal research design.

From a theoretical perspective, the behavioral results indicated that serial "cliffhangers" may work better in eliciting MVPA than episodic's "temporary relief." The motivational force created by a serial narrative structure was better sustained over time. In other words, children were apparently able to maintain the suspense established through the serial narrative delivery without losing interest over the long term. It is possible that the serial format resulted in greater motivation to resolve the outcome uncertainty, which could have translated into sustained interest and greater persistence in narrative-related exercise (Abuhamdeh et al., 2015). On the other hand, while the episodic format of the narrative engaged children in the beginning (e.g., the Visit 2 MVPA levels for the Episodic condition were relatively comparable to that of the Serial), their long-term behavior was not sustainable due to the temporary relief not being as strong or satisfactory over time as the serial plot. Therefore, they ended up playing the game less. These results have important implications for entertainment-education initiatives, which often use extended narrative presentations such as telenovelas or multi-episode radio dramas.

Interestingly, the two conditions did not differ in self-reported narrative immersion. It is possible that this was due to a ceiling effect; the children generally enjoyed both narratives. It is also possible that other unmeasured factors such as identification or parasocial interaction with the characters may be playing a more important role. Due to time

constraints, we were not able to include measures of all the potentially relevant narrative engagement constructs, but future research could consider a broader range of psychological variables. Additionally, these effects may have emerged from motivational influences that are independent of narrative immersion; future research should continue to explore the underlying mechanisms of these effects.

Similarly, the conditions did not differ in their self-reported PA motivation or perceived exertion (RPE). It is possible that the 8 to 12-year-old children's *self-reported expectations* regarding PA behavior after narrative exposure could be dynamic, if not volatile, and therefore would not match their *actual behavior*. Indeed, previous studies have indicated that PA behaviors in children under 11 years could not be measured in sufficient detail by the use of self-reports (Mindell, Coombs, & Stamatakis, 2014). Additionally, another review reported that no PA questionnaires for children were reliable and valid, with worse results in younger children than adolescents (Chinapaw et al., 2010). In other words, had we conducted this study using questionnaires as the only assessment tool, we may have fallen prey to a potential Type II error and failed to discover the significant behavioral difference among children. It is possible that self-report measures may be more accurate with adult samples, who may have greater self-awareness about their intentions or internal states.

Our study provided one example of how narratives and games can be combined. Another type of media that merges stories and games is interactive narratives (e.g., Green & Jenkins, 2014). These types of "choose your own adventure" narratives allow readers to choose the direction of the plot, and thus allow audiences to have a more autonomous experience. The use of a serial narrative combined with a game opportunity may be more similar to an interactive narrative in that it provides a greater opportunity for the player to imagine and in some ways participate in the next steps in the story. For instance, in the current study, the gameplay was linked to the narrative by allowing the children to "train" to help defeat the villain in the next part of the story. The use of a serial narrative may provide more opportunities for the player to anticipate or imagine a course of action for the next sequence of events, and this anticipation may motivate real-world behavior.

Additionally, serial narratives may be more effective at encouraging retrospective imaginative involvement (RII), which involves audiences' asynchronous involvement with narratives (i.e., thinking about the plot or characters after watching). After children watched each narrative episode, they may have experienced this retrospective, asynchronous narrative engagement (e.g., imagining what would happen next in the story). This kind of engagement may have encouraged them to temporarily expand the boundaries of their self, perhaps by taking on the role of the game hero and becoming more motivated to be strong to defeat the villain (Slater et al., 2018). Future research could measure RII for each narrative type. One additional possibility is that the suspense created by the serial narrative led to greater physiological arousal, and that this arousal translated to greater physical activity. Of course, this possibility is speculative, but if supported, it would have important implications for other tasks that might be influenced by arousal. Perhaps future exercise game and app developers could try to

harvest this "side effect" of suspense to motivate the users to exercise in a more vigorous manner.

From a practical perspective, given the higher MVPA behavioral outcomes, when designing potential PA interventions using AVGs among children, game writers or narrative designers should develop engaging narrative plots delivered in a serial fashion involving cliffhangers at the end of each episode. Creating stories that increase MVPA may not only increase children's short-term exercise but also motivate them to engage in the PA behaviors demonstrated in the AVGs and even potentially enhance their future intervention adherence. While our study focused on children, theoretically these results are likely to apply to adults as well.

Limitations and Future Directions

Our study is not without limitations. Additional research is needed on how to design different types of narratives for different types of AVGs given the importance of narrative's behavioral motivation in PA behaviors and its potential clinical application. We found a significant effect, but most of the AVG mini-games we used primarily focused on lower-body movement. Although *Shape Up* did result in MVPA among children (Hwang et al., 2019), it did not represent many other AVGs that focus on different types of body movement. Future narrative research should be conducted in multiple-AVG intervention scenarios to boost the external validity of the findings.

Additionally, since all participants in our study were screened for attentional or neurological disorders, the results may not be applicable to children with these conditions who might not have sufficient patience in waiting for the grand finale over several weeks. Instead, the episodic format of narrative structure might work better for this group, who are subject to higher obesity rates and other negative comorbidities (Rimmer et al., 2007). Thus, the narrative presentation styles should still be investigated in terms of their differing effects on narrative engagement and MVPA behaviors among children with a wide spectrum of developmental differences.

Additionally, while all children who enrolled in the study completed it, they may not be representative of 8 to 12-year-old children across the country. Wider population-based studies are needed. The participants only played the AVGs during their after-school program. As a result, the findings may not be replicated in other contexts, such as if the children played the AVGs at home. The research team's access to children was also limited by the schedule of the after-school activities in various classes, resulting in a relatively small sample size despite collecting data over two full semesters during the academic year, which might have contributed to the lack of significant self-report results. Similarly, despite a diverse participant base and an even split between boys and girls, the small sample size prevented us from examining specific racial and sex disparities further.

Last but not least, our intervention was not preregistered, and the study was conducted in only one school. Future studies should attend to these issues by improving

measurement instrument validity, preregistering the study protocol, and expanding the external validity by working with more children from more participating schools. Larger samples will also better allow mediational analyses for the observed behavioral effects.

Conclusion

Serial narratives that tell a story in an extended way resulted in more MVPA over time than episodic narratives among neurotypical children. It seems that the power of suspense and the cognitive desire for narrative completion afforded by the serial narrative outweighed the temporary relief or satisfaction from the episodic narrative among children. This difference was reflected in their actual behaviors, but not their self-report measures. Our findings strongly emphasize the importance of designing child-friendly and effective narrative plot structures for AVGs in PA interventions as well as choosing the appropriate tools to precisely and accurately assess children's health behaviors. Future story designers for AVG should identify optimal creative strategies in plot design to encourage all children to participate in PA with engaging narratives to maximize the narrative's behavioral potential. More broadly, our work provides additional theoretical and empirical guidance for developing extended narrative interventions for behavior change.

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