"Healthifying" Exergames: Improving Health Outcomes through Intentional Priming

Frank X. Chen
Computer Science Department
Stanford University
fxchen@cs.stanford.edu

Abby C. King
Stanford Prevention Research Center
Stanford University
king@stanford.edu

Eric B. Hekler
School of Nutrition and Health Promotion
Arizona State University
ehekler@asu.edu

ABSTRACT
Exergames, video game systems that require exertion and interaction, have been rising in popularity in the past years. However, research on popular exergames shows mixed health benefits, potentially due to minimal energy expenditure and decreasing use over time. This paper presents a 2x2 experimental study ($N = 44$), using a popular exergame, where we vary the framing of intention (i.e., "Gameplay" or "Exercise") and feedback (i.e., "Health" or "No health") to explore their single and interactive impacts on perceived exertion, objectively measured energy expenditure, affect, and duration of usage in a single session. Our study showed that participants primed with exercise used the system significantly longer than those primed with game play ($M = 49.2 \pm 2.0$ min versus $M = 39.3 \pm 2.0$ min). We discuss our results and possible design implications based on our single-session experiment. We conclude with a discussion on the potential impact of focusing on "healthifying" exergames—highlighting an exergames' dual purpose as both a game and exercise—as opposed to gamifying health behaviors.

Author Keywords
Exergaming; Priming; Persuasive Technology; Fitness

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human factors, Measurement

INTRODUCTION
A large body of research suggests insufficient physical activity increases the risk of chronic diseases and conditions such as cardiovascular disease and obesity [18]. Some commonly reported barriers to regular physical activity include cost, location, social anxiety, and lack of social support [15, 45]. The field of human-computer interaction (HCI) may offer valuable insights for individuals to overcome these barriers and reach the weekly recommended 150 minutes of moderate to vigorous intensity physical activity (MVPA) [37]. Video games for exercise, also known as exergames, have become increasingly popular (e.g., Wii Fit and Microsoft Xbox Kinect) [33]. Exergames can be used at a relatively low cost within a person's home to promote MVPA [22]. However, recent studies show mixed results for exergames in fostering sufficient levels of activity (e.g., MVPA) to confer health benefits [29, 36]. Furthermore, a three-month study of Wii Fit usage by eight families showed no significant health outcomes among its participants, potentially due to decreasing use over time [35].

Much of the current focus on exergames has emphasized game dynamics and feedback as the primary factors to be manipulated for promoting increased usage [34, 38]. However, previous work from psychology and more recently behavioral economics suggests that *priming* and *intentions* may have an impact on engagement and usage. Priming is a common technique in psychology whereby a researcher experimentally manipulates a stimulus to "prime" different responses from an individual. A meta-analysis suggests these techniques could positively influence health outcomes [5]. We contend that *intentional priming* has not received sufficient attention within the HCI literature. We propose intentional priming as a potential key design feature to be explored within exergames.

Our work fits into a growing body of HCI research focused on improving the translation of basic psychological/ behavioral economic principles into the design of behavior-change technologies (BCT) [21]. For example, Lee et al [25] conducted a series of randomized experiments on webpage design that incorporated lessons from behavioral economics on default options. Similarly, our research uses a randomized experiment to test basic psychological processes to inform improved BCT design. Specifically, our work focuses on exploring the impact of (1) priming for using an exergame (i.e., intention to use the system primarily as a game vs. as exercise) and (2) health feedback (i.e., providing a calorie counter or not, see Figures 1 and 2, workout mode includes the health feedback) on perceived energy expenditure, objectively measured energy expenditure, positive affect, and duration of use within a single session in an adult population. Our goal is to better understand the influence of these two mechanisms on exergame usage in a laboratory setting to inform later studies on more long-term use. We hypothesize that

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Figure 1. "Perform It" mode. Gaming feedback includes a point system, a multiplier (for a sequence of correct dance moves), and a glowing cue (for accuracy of dance move).

Figure 2. "Workout" mode. Health feedback includes a workout timer that persists between songs and a calorie counter.

exercise / health intention priming could increase energy expenditure and duration of use in a single session.

We begin with a review of (1) systems that provide feedback to encourage individuals to change behavior; (2) psychological research related to intentional priming. We follow with a description of our experiment and highlight key results. Finally, we discuss some design considerations that could be further explored in more long-term studies.

BACKGROUND

Exergaming Systems

An exergame drives physical activity through game play / feedback such as competition and the conference of points, tokens, and badges as mechanisms of feedback [1, 10, 11, 32, 34, 42, 47]. For this exergame to confer health benefits, at least two criteria must exist: (1) the exergame fosters sufficiently intense activity (i.e., MVPA, an activity intensity above 3 or more Metabolic Equivalent values or METs), and (2) the exergame fosters sustained usage resulting in an increased amount of MVPA that is maintained in the long-term.

Sufficient Intensity: In general, results are mixed with regard to the likelihood of an exergame facilitating MVPA. Specifically, researchers have found that among forty-six different Wii Fit activities, 67% were light intensity (less than three METs) and 33% moderate intensity physical activity (three to six METs) [29]. Furthermore, Bausch et al. found that the Wii Boxing and Wii Tennis games promoted 5.2 MET and 3.2 MET levels respectively, among young adults [7]. As such, some exergames can foster the appropriate intensity level but MVPA is not guaranteed.

Sustained Usage. The issue of sustained usage can be broken down into three related subdomains: length of bouts the game is played, total length of time played per week, and consistent use of the exergame in the long-term (e.g., using the system for several months to years to foster health benefits). Owens et al. [35] explored system usage of a Wii Fit within a home environment among eight volunteer families over three months. Results showed that the Wii Fit promoted sufficient duration of physical activity during the first 6 weeks (i.e., M = 21.5 ±9.0 min/day or 150.5 min/week) but usage dropped precipitously during weeks 7-12 (i.e., M = 3.9 ±4.0 min/day in the second 6 weeks). Not surprisingly, this study also found no health benefits. Similarly, Schwanda et al. interviewed 16 individuals on their long-term use of the Wii Fit [40] and found that all individuals reported significant decreases in usage over time; 7 reported decreased use due to a reduced motivation to accomplish goals, and the remaining 5 reported that they were not challenged by the exergame. Related to intentions, participants reported that the Wii Fit was "enough of a fitness tool to be useful […] but it wasn't fun enough to be played regularly as a game."

In sum, prior work suggests that some exergames promote a sufficiently high intensity level of physical activity to confer health benefits, but that this intensity level is not guaranteed across all games. Further, it may be possible to promote initial usage of an exergame, but that usage often drops quickly after only a few short weeks [17, 26, 27]. Building on this point, a core problem may be that many of these exergames are perceived as fitness tools rather than games, with the game-like elements "bolted on" and thus not deeply embedded in the user experience [23].

Intentions and Health

Within the health realm, the construct of intentions is an essential component of an important behavioral theory, the theory of planned behavior (TPB) [2]. Within TPB, an individual's intention to engage in a behavior was defined as a person's explicit intention to engage or not engage in an action, such as physical activity and much previous research suggests the predictive utility of explicit intentions on sustained engagement [4]. Research from psychology and behavioral economics provide insights on priming of intentions in the moment, which might be a particularly advantageous method for influencing intentions within an exergame.

Priming Intentions

Priming can occur through a variety of mediums such as text, visual cues, or audio files. For example, the Proteus Effect, a mechanism in which digital avatars are used to inspire future actions, is a form of priming that has been used to inspire exercise [49]. Another example outside of the technology realm is a study conducted by Crum et al.

In their study, room attendants in hotels were either primed to think or not think about the caloric expenditure of their everyday activity (i.e., cleaning a hotel) [13]. At baseline, 66.6% of these attendants reported not exercising regularly and 36.8% said they did not get any exercise at all, despite the fact that their job was a form of MVPA. Four weeks after the experimental intervention, both groups reported no behavior change (e.g., not starting an exercise regimen) but the experimental group showed a significant decrease in weight, blood pressure, body fat, waist-to-hip ratio, and body mass index relative to control. Further, this group perceived themselves as being more physically activity. These results highlight the possibility for priming to have an impact on behaviors that can impact health outcomes.

Beyond the potential subtle influence of priming on activity levels, priming can also influence mood. In a study on verbal priming for health, 48 young adults were given a 10-week exercise program [14]. The experimental group was informed that they were in a program to improve psychological well-being and given a fitness regime, while the control group was given just the fitness regime without a prime about the psychological benefits. Results suggested that the experimental group showed a greater increase in self-esteem and positive affect than the control group while both groups showed similar fitness benefits. Desharnais' experiment showed a significant difference for attitude.

We draw upon research from exergames and intentions/intentional priming in the creation of a novel experiment. We examine the use of priming an exergame to encourage health behavior change in a single session.

Hypotheses

Based on our review of the exergame literature, an exergame should elicit at least 3 METs to confer health benefits and the exergame should promote sustained use within a single session (i.e., supports at least 10 minutes but more optimally, at least 30 minutes per session of use), ideally over a long period of time (i.e., accruing 150 minutes per week of moderate intensity activity over several months to years). This pilot research explores if intentional priming may be important to consider in the design of exergames beyond just feedback. Support for intentional priming in this single session experiment would provide important justification for the far more resource-intensive efforts of exploring intentional priming on longer-term usage in subsequent research.

To explore these issues, we designed a 2x2 factorial experiment (Intention Prime Factor: "Game play" vs. "Exercise", Feedback Factor: "Health" vs. "No health") described in greater detail below. This experimental design allows us to parse out the individual and interactive impacts of intention priming and health feedback on perceived and actual energy expenditure, positive affect, and duration of usage within a single session. Based on our review of the literature, we hypothesize the following effects:

Hypothesis 1: The "Exercise" prime will result in significantly higher perceived and actual energy expenditure relative to the "Game" prime.

Hypothesis 2: The "Health" feedback condition will result in significantly higher perceived and actual energy expenditure relative to the "No health" feedback condition.

We hypothesize these effects based on the previous research suggesting that general health priming can have an impact on health outcomes. The likely mechanism for this would be either implicit (i.e., impact only on actual energy expenditure) or explicit (i.e., impact on both perceived and actual energy expenditure) influence of health priming on outcomes. As the health feedback mechanism is feedback about the health benefits of the exergame, we hypothesized that it would work similarly to the health intentional priming.

Hypothesis 3: The "Game play" intentional prime will result in significantly higher positive affect relative to the "Exercise" prime.

Hypothesis 4: The "No Health/Game Only" feedback condition will result in significantly higher positive affect relative to the "Health and Game" feedback condition.

We made these hypothesizes because games are usually leisure activities undertaken for the amusement of their players. When an exergame is thought to be "exercise" (either via intentional priming or via the feedback provided), the action may move from being an optional choice action to a required action. McGonigal writes, it is essential for any game, particularly serious games, to be perceived as a choice instead of a requirement to ensure the game remains fun and enjoyable [28]. Thus, priming an exergame to be exercise may come at the psychological cost of individuals perceiving exergames as a requirement rather than as a choice (and thus, less enjoyable).

Finally, we hypothesize the following related to duration:

Hypothesis 5: The "Game play" prime will result in significantly longer game play relative to the "Exercise" prime.

Hypothesis 6: The "No Health/Game Only" condition will result in significantly longer game play relative to the "Health and Game" feedback condition.

We made these hypothesizes based on the potential for the health priming and feedback to deleteriously impact the perception that the exergame is a requirement. If it is perceived as a requirement rather than a game, it is hypothesized that this reduced enjoyment will extend to reduced length of gameplay.

Figure 3. Photograph of experimental room and a participant in exercise intention prime. There are visual cues on the projector wall "Exercise Time" and "Have a Great Workout."

METHODS

Dance Central for Xbox Kinect

We chose Dance Central for Xbox Kinect for a number of reasons. It was one of the first video games released for the Xbox Kinect. The Xbox Kinect detects movement and maps skeletal movement as gestures to use as cues for navigation and gameplay. Based on this, the Xbox Kinect's controlling mechanism fosters full body movement. Particularly when complemented by the actions elicited from Dance Central, we believed that participants would likely engage in at least the 3 MET threshold. Further, Dance Central included the capability of activating and deactivating workout mode (See Figs. 2 & 3), thereby providing a useful parameter for exploring health feedback.

Development of the Priming Manipulation

We iterated upon our experimental procedure three times before the final study design. We used a limited set of participants (n = 8) whose data are not included in the final protocol. In our first iteration, we used a general frame of "stress relief" for recruitment purposes to mask the true purpose of the study, which appeared to work as a believable cover story. Further, we initially tried to prime only within the instructions given by mentioning either "exercise" or "game." Specifically, participants in the "game" intention priming condition were told to "play the Kinect Dance Central program to relieve some stress. The game is a very fun way to pass time and relax." Alternatively, participants randomized to the "exercise" priming condition were told to "exercise using the Kinect Dance Central program to relieve some stress. This exercise program is a great way to get some physical activity and relax." The study proctor gave all other oral instructions with references to the exergame as either "exercise" or "game." All participants in the first wave of participants described Dance Central as a game, not exercise even in the exercising priming condition, suggesting the likelihood that Dance Central is perceived first and foremost as a game. In our second iteration, we added contextual cues such as "Exercise Time" and "Have a Great Workout" near the screen for exercise priming (see Figure 3). In the second iteration of testing, we found better evidence for those in the exercise prime to think of using Dance Central as exercise. That said, some individuals appeared to be distracted based on the novelty of the situation for using the system. To counteract the novelty effects, in the third iteration we gave instructions prior to turning on the Xbox and added "Break It Down" session (i.e., a training session built into Dance Central) for performing basic dance moves on the easiest setting for all participants. In the third iteration, participants described the systems according to the appropriate primes in interviews. Specifically, individuals who were primed to view the system as a game reported Dance Central as a game. In contrast, those in the exercise priming condition described the system as primarily exercise.

Study Design

Participants were recruited via email, flyer, and online bulletin board postings for a "Kinect as a Stress Reliever study." Participants were excluded if they owned and / or regularly used the Xbox Kinect. No compensation was given for participation.

The lab experiment, which was approved by the appropriate institutional review board, consisted of one session in an empty room in the basement of a science building at the University. An Xbox, Xbox Kinect, and projector were placed on an end table near the middle of the room. The projector used a wall as a screen (Figure 4). A tape marking on the floor indicated where participants should stand (i.e., 8 feet away from the screen/Kinect sensor).

Before the experiment, the study proctor randomized each participant to one of four conditions based on the two experimental factors: (1) intention priming, and (2) feedback. After receiving informed consent, a study proctor instrumented the participant with a strap on the participant's chest (Zephyr Bioharness, described later). The participant then took a preliminary survey on their current affect.

Feedback Factor: For those in the health feedback condition, the study proctor changed the mode to "Workout mode" (see Figure 2). Those randomized to the no health feedback condition did not have the workout mode turned on.

Priming factor: The study proctor instructed the individual to use the system for at least 10 minutes to relieve stress but to exercise / play (depending on condition) as long as he / she liked and that the proctor would return in 60 minutes; if the participant wanted to finish early, he / she just needed to come to the room next-door to find the research proctor. The participant was asked to choose 1 of the 32 songs (at easy, medium, or hard difficulty settings) to "relieve stress" through "playing" or "exercising" depending on the priming factor.

No constraints were placed on the dance sequence or difficulty; thus, a participant could use the system with the exertion level and pace she / he desired. This freedom of choice was essential to allow the natural MET value for

playing the game without any constraints because the level of difficulty would likely impact energy expenditure. A hard song usually required more complex and faster movements, thus, potentially increased energy expenditure. Further, no constraints were placed on how to use Dance Central to allow for differences between conditions on all outcome measures to be exhibited through the natural choices of the participants based on the experimental manipulations.

After the Dance Central session, each participant was asked to complete a survey and a semi-structured interview. The interview explored what the individual did during the session (e.g., "Tell me about your activity during the [game / exercise]") and their usual exercise habits (e.g., "What are your habits for exercise? Why do you exercise?").

Measurements

The primary measurements were perceived exertion, energy expenditure (EE), positive affect, and duration of session. The Borg scale for rated perceived exertion (RPE) [8] has been found to correlate to heart rate [9] in both anaerobic exercise routines [16] and aerobic exercise routines [44]. EE was measured using a device that measures heart rate, activity level (as measured via accelerometry), and respiration rate, called the Zephyr Bioharness [50]. Previously validated algorithms have been developed for translating heart rate, activity level, and respiration from the bioharness into METs on a minute-by-minute basis [3, 39]. As we were interested in the overall MET value for the entire session and because duration was being accounted for, we averaged the minute-by-minute MET estimates of energy expenditure into an average MET energy expenditure across the entire session. Positive affect was measured using the positive and negative affect schedule (PANAS) [48]), which is a well-validated measure for assessing moment-to-moment changes in positive affect. Duration of the session was measured via a stopwatch. We also included surveys related to exercise habits [46] and video game usage [41] as possible control variables.

Our semi-structured interviews were completed after the experiment to determine if our priming manipulation worked and to glean insights into intentions and feedbacks that may not be evident from the quantitative data.

Statistical Analysis

Descriptive statistics (i.e., means and standard errors) were calculated for all key study conditions. Pearson Product Moment Correlations were used to examine correlations between continuous variables. For predictions of positive affect, the key hypothesis focused on changes in positive affect after participating in the Kinect session. Because change scores tend to inflate standard error estimates [12], we used residualized change scores to control for any pre-session differences in positive affect.

RESULTS

Participants

Forty-four undergraduates, graduates, post-doctoral fellows, and staff participated in this one-session study (M_{age} = 26.5 ±7.1, 56.8% men). 70.4% of participants reported regular exercise. Age was not associated with RPE, actual EE, or duration in this sample (r-values<0.25, p-values>0.10). Through the remainder of this paper, we use shorthand to describe each participant <**Gender** (*M* for Male or *F* for Female), **Priming factor** (*G* for gameplay or *E* for exercise) × **Feedback factor** (*nH* for game only or *H* for health & game)>.

Intention Prime Manipulation Check

An important first step was to validate the priming. To determine this, participants were asked to describe their sessions during the semi-structured interview to explore whether they would describe the exergame according to their randomized frame (i.e., viewing the exergame as a game or exercise). Following the session, we found the responses in line with our experimental manipulation All individuals in the exercise and gaming priming , in response to the prompt, "Tell us about your session," described their sessions primarily according to their respective experimental manipulations. Eight participants in the exercise priming and three participants in the gameplay priming mention the dual benefits of exercise and gaming. It is important to note that the three individuals in the game priming condition that also mentioned the dual benefits of exercise and gaming exercised regularly. Examples of responses including:

> *"I played through many songs […] I really liked and had a lot of fun. I found myself becoming very competitive, more than I had imagined I would [because I do not play a lot of games]." <M, G×nH>*

In comparison, one participant randomized to the exercise condition discussed fitness and routines:

> *"This could be one of the things I do to train. What you see a lot on dance teams is it's difficult to learn new routines due to lack of feedback on what I'm actually doing…" <F, E×nH>*

Finally, eleven individuals discussed the dual benefits:

> *"I think this is a great game. I typically run and do strength training and burn about 360 calories at the gym per session. You could have used a different game… It's still not as efficient as a workout at the gym." <M, E×nH>*

In this case, the participant, randomized to the exercise priming condition, talked about his session as a game and compared the Kinect exercise to routine gym exercise. As such, the participant recognized the activity as potentially serving dual purposes.

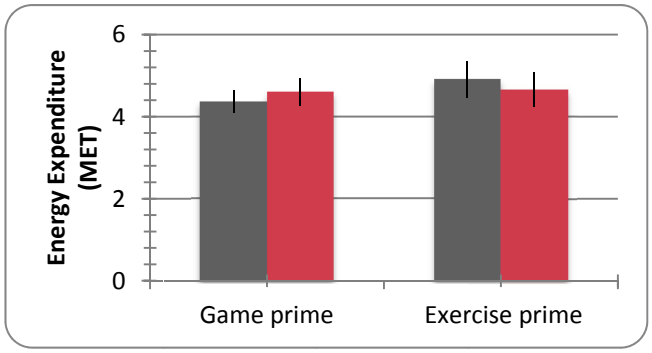

Figure 4. Energy Expenditure grouped by condition.
Grouped by: ■ "No Health" then ■ "Health" feedback

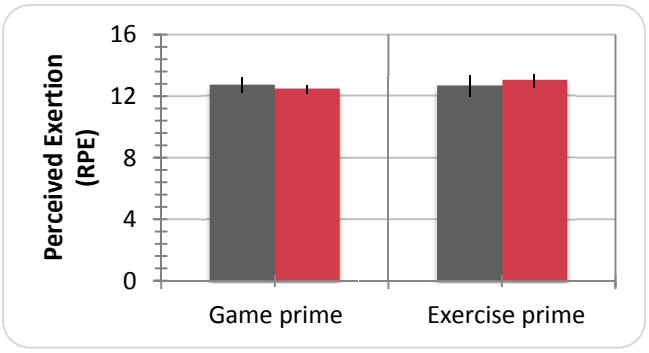

Figure 5. Perceived Exertion grouped by condition.
Grouped by: ■ "No Health" then ■ "Health" feedback

Energy Expenditure and Perceived Energy Expenditure

The grand mean for overall energy expenditure was M_{MET} = 4.5 ± 1.1. Based on this, the average MET value for activity was within the moderate intensity realm, thereby suggesting that using Dance Central can result in meaningful physical activity [37]. Further, the grand mean for perceived exertion neared the "somewhat hard" realm (i.e., M_{RPE} = 12.8 ± 1.7).

Analysis of variance (ANOVA) revealed no significant predictors of perceived exertion or energy expenditure (*p*-values>0.54, see Figures 4 and 5) across all conditions.

Positive Affect

ANOVA predicting residualized change scores of positive affect suggested a trend for feedback influencing change in positive affect ($F(1,43) = 3.62$, $p = 0.065$). Post hoc power analyses suggested a sample of 68 would have been required for statistical significance. All other variables (priming and the interactions of priming and feedback) were not associated with post-session positive affect (*p*-values > 0.29, see Figure 6).

Duration of Use

ANOVA revealed a significant effect of intention on duration of use ($F(1,43) = 6.6$, $p < 0.05$). Specifically, participants used the system significantly longer for the exercise priming condition (M = 49.2 ± 2.0 min) than the gameplay condition (M = 39.3 ± 3.0 min). This ran counter to expectations (see Figure 7). All other variables were not significant (*p*-values > 0.33, see Figure 7).

INTERVIEW RESULTS

In this section, we outline key themes that arose from the semi-structured interviews to provide context for the quantitative data and to provide further insights into potential design parameters within an exergame context.

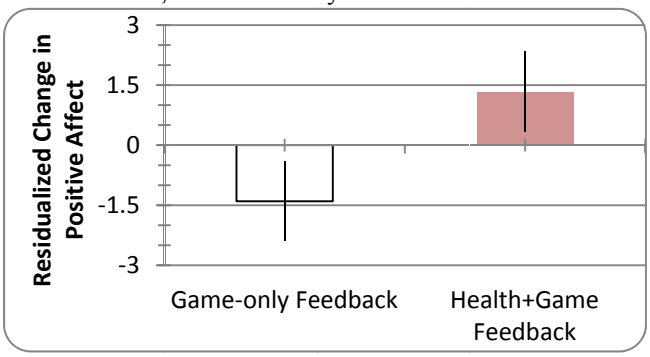

Figure 6. Residualized change scores in Positive Affect for game only feedback and Health Intention & Game Feedback.
Grouped by: ■ "No Health" then ■ "Health" feedback

Frame Exergame Use with Similar Prior Experience

Participants who had used the Wii Fit in the past (n = 5) contrasted the energy level difference of their use of other exergames against their use of Dance Central: some said it was "harder" and it was harder to "cheat" by only using their arms. A former Wii user <*F*, *E×nH*> highlighted the fine-tuned feedback compared to her mirroring videos streamed from the internet and the extra energy she used with this system as compared to the Wii where "you only move your hands."

> *"The level of energy to play games like the Kinect and Wii are interesting. When I first got Wii, I felt it was very tiring at first; then I learned how to conserve my energy and cheat the system. I could get very high scores and maintain it. At first I couldn't play for more than 30 minutes. Now I have learned to play and limit my movements to play for hours [on Wii]."* <*M, G×H*>

Participants with dance experience (n = 3, all female) described different affordances of using an exergame to learn dancing. A former competitive dancer <*F, G×H*> described being able to slow down complex movements in break-it-down mode and receiving feedback extremely useful; this personal feedback process is typically not accommodated in dance instruction courses with many people.

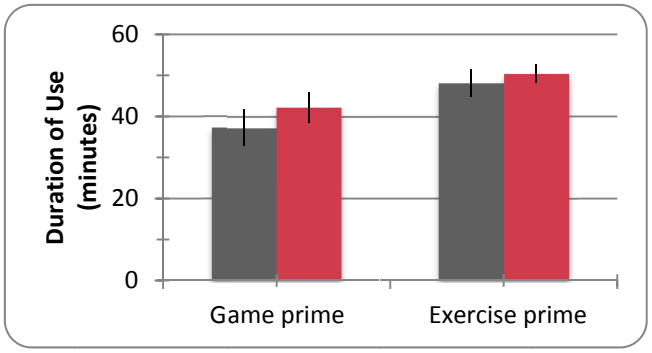

Figure 7. Duration grouped by condition.
Grouped by: ■ "No Health" then ■ "Health" feedback

"This could be one of the things I do to train. What you see a lot on dance teams it's difficult to learn new routines due to the lack of feedback on what I'm actually doing." <F, E×nH>

In these interviews, prior experience (including whether the individual reports regular exercise) seemed to play a role in perceptions of the system. Future work could explore how prior experience influences measures such as exertion or positive affect compared to those who do not have these prior experiences. Unfortunately, we did not have a sufficient sample to explore these issues in more detail.

Use of Health Feedback in Exergames

One of our hypotheses was that visual health feedback (i.e., calories burned and time spent in the workout) would influence the time of usage and energy expenditure. Surprisingly, health feedback was not predictive of duration of use or energy expenditure in our experiment.

While most individuals mentioned the visual game cues as fun and exciting, no individuals mentioned the health feedback as particularly beneficial. In fact, one participant had a negative reaction to the exercise prime and health feedback that was in line with our original hypothesis.

"I did not use the feedback […] I play sports. I don't run or lift weights. Exercise is boring, rather than doing something monotonous I like to play games." <F, E×H>

While the health feedback in this study did not significantly impact measurements, health feedback (e.g., calories burned) is a common theme in many exergaming systems [42]. Future work might explore health feedback that is more deeply embedded in the activity itself and not "bolted on" [23].

Exergames as a nudge for further physical activity

Eight individuals from game priming and five from exercise priming, when asked about exercise reported a desire to start exercising again during the semi-structured interview. These participants reported the use of this exergame made them realize they needed to do more physical activity while others described the feeling in more specific contexts.

Focus on gaming cues

Eight participants reported appreciating the visual and auditory game-like incentives to succeed in their activity. For example, one participant mentioned:

"There is a lot of incentive to do well. It's a lot more fun when you do it well and when you can do the right moves. The feedback was really helpful to help me do well." <M, E×nH>

Social Element

The design of this study purposefully left out social elements related to using Dance Central with others as that would have likely introduced a confound to the study. Interestingly, many participants volunteered insights on their play or exercise routines by giving unsolicited social information on how much their own behavior could have changed if there was social activity in the experiment.

Five participants talked about the importance of social context in the experiment without prompting. For example, "I wish I could play this as a team so there's more of a sense of cooperation or competition." <*F*, *E×H*>. Another participant <*F*, *E×H*> who was formerly on a dance team, noted that the social connections formed through dance helped relieve stress. Finally, one participant implied that the social elements would have been problematic and contrasted his session to other games he plays socially:

"I felt very relaxed while I played alone. If I played with others, I would feel pressured if I didn't dance as well as others." <M, G×nH>

DISCUSSION

In this study, we explored how intentional priming and feedback may influence perceived and actual energy expenditure, changes in positive affect from using the system, and duration of usage in a lab-based single session experiment. Results of our study confirmed that Dance Central could inspire individuals to engage in moderate intensity physical activity. If Dance Central can also promote long-term usage, then these results suggest that Dance Central may be a useful tool for meeting national physical activity recommendations. Results also suggested that providing health feedback resulted in a trend for more positive affect compared to the game-only feedback. This result was counter to expectations as we hypothesized that a more pure game focus would elicit more positive affect. In addition, results also suggested that individuals randomized to the exercise priming condition used the system longer in a single session than those randomized to the gameplay condition. All other analyses (i.e., exploration on how priming or feedback predicted perceived exertion or energy expenditure) revealed no significant effects in this single session.

The determination that Dance Central can promote moderate intensity physical activity has an important implication for the broader realm of exergame research. Previous research has suggested that some Wii Fit games promote light but not necessarily moderate intensity physical activity [29, 36]. While the Wii Fit can be perceived as a starting point for inspiring individuals to start to become more physically active, individuals may not be able to sustain sufficiently high levels of intense physical activity for health outcomes using the Wii alone [40]. Our results for Dance Central, coupled with the full body movement required from the Kinect, suggest that the Kinect sensor system might more consistently foster the appropriate intensity of activity. However, future research with other Kinect games is required to confirm this point.

The key finding from our quantitative data suggested that individuals who were primed to think of the exergame as

exercise used the system for a significantly longer period than those primed to use the system as a game in a single session. This was counter to expectations that were based on the hypothesis that priming the activity as "exercise" would implicitly change the experience of using Dance Central as a "want to" to a "have to" activity and thus reduce interest in using the system for a longer session. There are several parts to our data that suggest a somewhat more nuanced understanding of game design than our original hypothesis. In particular, eleven participants perceived the dual purpose of the exergame (i.e., as both exercise and a game). Further, many of the individuals within the exercise-priming condition stated in the semi-structured interviews that they wanted to "work out" for a long enough time to get their exercise in for the day and therefore not have to go to the gym later. It is important to note here that the vast majority of participants (70.4%) reported exercising regularly. Based on this, it appears that those individuals who are already active and primed to think about this as "exercise" may persist in using the system partially because it is fun but *also* to ensure they receive the health benefits. In contrast, those individuals who only perceived the system as a game likely stopped playing the game as soon as it was below some threshold of fun. As such, there was no added motivation beyond just enjoyment to ensure continued engagement. This explanation fits with other work from psychology showing that self-identity might be a driver for persisting in an action in the long term [43].

Counter to expectations, we did not find any significant impact of intention priming or feedback on perceived exertion or actual energy expenditure. It is plausible that this non-significant result was due to our small sample size. Indeed, if only looking at the patterns of the data, the results suggest that modestly more energy was expended within the exercise-primed group overall. Future research with a larger sample could be conducted to better explore the potential impact of intention on energy expenditure within a properly powered study (based on current effect size estimates, a minimum sample of 72 would have been required). Barring running a full study, our results suggest that an exercise intention and health feedback likely do not play an important role in increasing activity intensity, at least within a game that already promotes average MET values around 4.5. This suggests that game dynamics (e.g., full body movement that can be achieved within the Kinect) may be of primary importance for exergames to meet the moderate intensity threshold in a single session.

With regard to positive affect, our results suggest that receiving health feedback promoted a trend towards increased positive affect more so than the game-only feedback. This finding, while counter to initial expectations, makes sense within the context of our interview data and the duration findings. Specifically, our formative work coupled with our interview results both suggest that Dance Central is perceived primarily as a game. As such, providing health feedback may have been a mechanism for highlighting the dual benefits (i.e., fun and health) that could be achieved via Dance Central. Based on this, a design parameter to further explore is to more explicitly highlight its dual purpose of both fun and health.

Limitations

There were several limitations to the study. First, only individuals connected to a major university were recruited and the vast majority of these participants reported exercising regularly. As such, there are potential problems with generalizability. Further, this study utilized an in-lab single session experimental design. As such, no conclusions can be drawn about long-term usage. Finally, while the data support our intentional priming manipulation, there were some individuals from both the gameplay prime and exercise prime that discussed the dual purpose of the game. This does not run counter to our intentional prime, however, as each participant explicitly mentions their original primed condition before discussing the dual role of both exercise and gameplay in their session. It is important to note that all of the individuals in the gameplay priming condition that also discussed exercise were regular exercisers and enjoyed exercise. As such, it is not surprising that they might perceive the dual purpose of the activity. Further, for the exercise prime condition, it appeared that Dance Central was perceived primarily as a game with it only being perceived as exercise after a strong manipulation based on our formative work. As such, the greater number of individuals recognizing the dual purpose of exercise and play in the exercise prime (eight) compared to the gameplay prime (three), while not definitive, is an interesting outcome of our study.

Implications and Future Directions

The results from our work provide an intriguing counterpoint to common practices for developing exergames. An emphasis for many exergames is "gamifying" exercise through the addition of points, badges, competition, and similar gaming elements [6]. The implicit motive for "gamifying" exercise is that exercising needs to be more fun to promote engagement.

Our results raise some questions about the value of gamifying exercise, as it was the health feedback and exercise priming that improved enjoyment and usage. We believe that this may have occurred because of the strong game dynamics in Dance Central, which we then augmented with our "healthifying" elements (i.e., intentional priming and health feedback) to make the system a more successful exergame. Our results suggest that the design of an exergame may be improved if emphasis is placed first on good game mechanics that foster a specific behavior such as dancing in Dance Central and then supplemented with "healthifying" the game via strategies like intentional priming and health feedback. The goal of this healthification would be to highlight the dual benefit/motivations for engaging in the behavior (i.e.,

healthy and fun). This hypothesis requires additional research, particularly with longitudinal studies but this research does support the likely value of exploring this within more resource-intensive longitudinal studies.

CONCLUSION

This work explored the impact of intentional priming and health feedback on the use of an exergame, Dance Central, within a single session. Our experiment with 44 participants confirmed that this exergame could elicit moderate intensity physical activity. Results also suggested that priming the use of the system for exercise increased duration of use and that providing health feedback within the session elicited a trend towards increased positive feedback in a single session. These results were counter to expectations, but highlight a potential for placing more emphasis on "healthifying" engaging games over "gamifying" health behaviors. These results should be interpreted cautiously however, as the impact of "healthification" may change as the person uses the system over an extended period.

We believe that this "healthification" process may be particularly impactful for well-designed games because it can highlight the potential dual purpose of using the system (i.e., for both fun and health). Emphasizing this dual purpose in a highly engaging game may be key for eliciting greater positive affect and longer sustained use, as the person is achieving success in two realms, a "two birds with one stone," mentality. Future research should further explore this "healthification" concept to promote more long-term use of exergames, a key problem with current exergame systems.

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