CARING FOR MOBILE PHONE-BASED VIRTUAL PETS CAN INFLUENCE YOUTH EATING BEHAVIORS

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This study tests the effects of feedback from a virtual pet on behavior change. A randomized field experiment with 39 adolescents in the US examined how a mobile phone game influenced their likelihood to eat breakfast. Manipulations included varying positive and negative visual feedback in response to participants' photos of breakfast meals. Results indicate that participants with a virtual pet that provided both positive and negative feedback were twice as likely to eat breakfast than those with a pet that provided only positive feedback or participants in the control condition.

KEYWORDS adolescents; experiment; feedback; health; mobile phone technology; virtual pet; youth

Persuading adolescents to change their eating behaviors is a unique developmental challenge. Young people often fail to make optimal nutritional decisions appropriately (Story, Neumark-Sztainer, & French, 2002), due to personal preferences, lack of nutritional knowledge, and established behavioral patterns (Larson, Story, Wall, & Neumark-Sztainer, 2006). Although there have been various approaches to encourage young people to eat breakfast more often, many of these campaigns have been ineffective (Kothe, Mullan, & Amaratunga, 2011). Mobile technologies offer a platform for delivering effective health interventions (Grimes, Kantroo, & Grinter, 2010; Peng, 2009). This study examines whether caring for oneself via a virtual pet can result in behavior change through several mechanisms uniquely deliverable through mobile technology. To our knowledge, this is among the first studies to test efficacy of mobile technologies to motivate adolescents to make healthy nutritional choices.

Rationale

Skipping breakfast is becoming a common behavior in the United States population and has been linked to health-compromising behaviors and lifestyles among adolescents (Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003), such as poor diet, smoking (Barker, Robinson, Wilman, & Barker, 2000; Sjoberg, Hallberg, Hoglund, & Hulthen, 2003), infrequent exercise (Aarnio, Winter, Kujala, & Kaprio, 2002; Keski-Rahkonen et al., 2003), and concerns about body weight (Barker et al., 2000; Cohen, Evers, Manske, Bercovitz, & Edward, 2003; Shaw, 1998). Unfortunately, as children and adolescents get older, they tend to skip breakfast more than any other meal (Raaijmakers et al., 2010; Siega-Riz, Popkin, & Carson, 1998).

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Research suggests that eating breakfast, as part of a healthful diet and lifestyle, can positively influence children's health and well-being. Rampersaud, Pereira, Girard, Adams, and Metzl (2005) summarized the results of 47 studies examining the association of breakfast consumption with nutritional adequacy, body weight, and academic performance in children and adolescents. The researchers concluded that even though the quality of the breakfast consumed varied within and between participants, children who report eating breakfast regularly tend to have superior nutritional profiles, be less overweight, have improved cognitive function, and demonstrate higher academic performance than their breakfast-skipping peers (Rampersaud et al., 2005). These findings emphasize the importance of developing intervention programs to decrease breakfast skipping among adolescents.

Mobile Technology and Health

Adolescents in particular are attached to their phones. By the time they graduate from high school, 85% of US teenagers own a phone, and many of those have owned them since middle school (Rideout, Foehr, & Roberts, 2010). Teens consider the phone a fashion statement as well as a tool for achieving personal independence (Ito, 2003). Some have argued that mobile phones may even act as a surrogate for human companionship (Humphreys, 2005). So they don't miss a call, many teenagers will even sleep with their mobile phones (Lenhart, Ling, Campbell, & Purcell, 2010).

Games for Health

Both desktop video games and, more recently, mobile phone games have been viewed as positive mechanisms for health behavior change (Grimes, Bednar, Bolter, & Grintner, 2010; Lieberman, 2009). Games have aided in the management of weight loss and dieting (Peng, 2009; Staiano & Calvert, 2010), as well as chronic diseases such as diabetes (Brown et al., 1997) and asthma (Lieberman, 2001). Mobile phone games, in particular, have recently showed promise in generating positive health outcomes. Mobile games have been used to increase physical exercise, improve diet adherence and increase awareness about health and unhealthy foods (Grimes et al., 2010; Lee, Chae, Kim, Ho, & Choi, 2010; Lin, Lindtner, & Strub, 2006). Given the evidence suggesting that mobile phones and games can be effective in promoting health-related behavior change, we propose to examine how interaction with a virtual pet game on a mobile phone can help young people maintain healthy eating routines.

Pets as Persuaders

In real life, the human–pet bond has multiple health benefits for human caregivers (Allen, Blascovich, & Mendes, 2002; Barker & Wolen, 2008; Friedmann & Son, 2009). Although limited research has investigated the benefits of human relationships with virtual pets, previous studies have shown that owners get attached to their virtual pets (Donath, 2004); they can be used to encourage physical activity (Lin et al., 2006) and promote environmentally responsible behavior (Dillahunt, Becker, Mankoff, & Kraut, 2008). In fact, young people are likely to feel emotional connections with animated agents, a condition that has been found to enhance learning (Moreno, Mayer, Spires, & Lester, 2001).

When agents represent the actions and consequences of the user, they can serve as a "teacher" to the self, especially in e-learning situations that aim to initiate healthy behaviors. These technologies enable a behavioral action in one's real life to forecast future consequences in a virtual or simulated life (Bailenson & Blascovich, 2004). The ultimate goal of such visual representations in the health context is to instigate personalized, interactive learning that functions to strengthen areas of user weakness without appearing critical or singling out a user publicly (Sheth, 2003). Based on this evidence, we proposed the following hypothesis:

H1: Adolescent mobile phone users interacting with a virtual pet game that responds to their breakfast behaviors will report eating breakfast more often than those who do not have a pet.

Motivating Behavior Change

Social cognitive theory (Bandura, 1986) offers guidance in how to effectively design and deliver messages that motivate change in adolescent eating behavior. According to Bandura, humans possess a unique ability to observe and mentally retain behaviors modeled by others, but when presented with a behavioral decision, they must be independently motivated to engage in a similar behavior. Factors such as the observation of associated rewards and punishments provide a form of feedback that, together with sufficient self-efficacy, can motivate behavior change. New technologies have the potential to deliver behavioral models and tailored feedback effectively (Sourin, Sourina, & Prasolova-Førland, 2006).

Feedback

Findings on the relative value of positive versus negative feedback have been inconsistent (Fox & Bailenson, 2009). In a recent meta-analysis of studies on vicarious punishment, a form of negative feedback, participants exposed to such interventions consistently demonstrated effective behavior change ($d = .58$) (Malouff, Thorsteinsson, Schutte, & Rooke, 2009). On the other hand, research has shown that positive feedback alone is a stronger mechanism for affecting long-term adaptation of new behavior than negative feedback or the two together (Ilies & Judge, 2005; Lin et al., 2006). Scholars have argued that negative feedback on health behaviors is a particular problem because when people are told that they did not reach a goal the feedback may result in negative emotion and a decrease in motivation (Consolvo, McDonald, & Landay, 2009). For young people in particular, negative feedback alone may cause anxiety and depression (Alloy, 2001).

To better understand the role of feedback in motivating behavior change in the context of mobile technology and virtual representations, we posed the following research questions:

RQ1: Will participants who receive both positive and negative feedback from their pet eat breakfast more regularly than those who receive only positive feedback and those without pets?

RQ2: Will participants who receive both positive and negative feedback from their pet eat healthier breakfasts than those who receive only positive feedback and those without pets?

Attachment to Pet

Positive or negative feedback may also influence how attached teens become to their pets. Participants who receive negative feedback in the form of a sad pet may find their pets more believable, as appropriate emotional responses enhance the realism of virtual characters (Shapiro, Pena-Herborn, & Hancock, 2006). A pet that becomes sad and happy is more representative of a real animal than a pet that never becomes sad. Having a sad pet may thus more strongly activate the "human – pet" attachment bond, which is based on the role of humans as caregivers (Archer, 1997). However, seeing a pet become sad may instead result in participants distancing themselves from the virtual creature in order to reduce dissonance and feelings of failure (Lin et al., 2006). Similarly, a pet that never becomes sad might result in greater attachment because that pet is fun and easy to care for. Given these arguments, we asked:

RQ3: Will participants who receive only positive feedback from their pet report greater attachment to the pet than those who receive both positive and negative feedback?

RQ4: Will participants who receive only positive feedback report being more motivated to help the pet become happy than those who receive both positive and negative feedback?

Self-Efficacy

Because feedback occurs as a direct result of behavior, it is closely related to the concept of self-efficacy. Bandura (1977) posited that efficacy expectations are based in part on performance accomplishments and vicarious experiences. Both negative and positive feedback from the pet (vicarious experience) may influence one's eating behaviors (performance) in a prosocial way, especially if participants observe their pet moving toward a happier state and increase in self-efficacy. For example, adolescents with avatars that respond appropriately to food intake by either gaining or losing weight tend to report an increase in eating-related self-efficacy (Peng, 2009). However, exposure to positive feedback alone may also increase self-efficacy.

RQ5: Will participants who receive only positive feedback from their pet report greater self-efficacy for eating breakfast (RQ5) and caring for the virtual pet (RQ5a) than those who receive both positive and negative feedback, or participants who do not have pets?

Perceptions of Importance of Healthy Eating

Our main goal was to examine differences in breakfast eating behaviors, but we also wanted to test how well the virtual pet game affected one learning outcome: perceptions of how important it is to eat healthily. One would hope that, along with behavior change,

participants have a useful conception of *why* they are behaving a certain way (Lieberman, 2006). For example, if participants are not learning anything from the experience, but are just trying to "win" or simply don't like seeing their pet sad, little is gained when the game ends. Alternatively, having a pet that never becomes sad or distressed, even when the participant skips breakfast or eats poorly, may activate unintended constructs in the mind of the user (Byrne & Hart, 2009). For example, participants who skip breakfast but do not see their pet become sad may develop the idea that eating breakfast is not very important.

RQ6: Will participants who receive only positive feedback from their pet report that eating healthily is more important than those who receive both positive and negative feedback or participants who do not have pets?

Attitudes toward Intervention

To achieve their intended effect, games designed to encourage healthy behaviors should be enjoyable for the participants (Garris, Ahlers, & Driskell, 2002; Lieberman, 2006; Peng, 2009). In fact, Malone (1981) argued that to increase intrinsic motivation, activities should be fun, challenging, evoke curiosity, and consist of fantasy. On the one hand, seeing one's pet become sad in response to eating behaviors might make the game less enjoyable. On the other hand, *not* seeing a sad pet might make the game less challenging and cause players to lose interest or not put in effort. In order to test the varying effects of positive and negative feedback on these factors of the game, we asked:

RQ7: Will participants who receive only positive feedback from their pet report that the game was more enjoyable (RQ7) and held their interest longer (RQ7a) than those who receive both positive and negative feedback or participants who do not have pets?

RQ8: Will participants who receive only positive feedback from their pet report that they expended more effort (RQ8) and are more skilled at the game (RQ8a) than those who receive both positive and negative feedback or participants who do not have pets?

Method

Participants

Thirty-nine adolescents in seventh and eighth grade ($M = 13.1$ years, $SD = 0.70$, range = 12–14) were recruited from three classes in one middle school in a Northeastern US agricultural community with a median household income of $44,808 in 2009 (City-Data, 2011). Eighty-four percent of the sample was Caucasian, and 16% identified themselves as biracial, of mixed race, or other. There were slightly more males ($n = 22$) than females ($n = 17$).

Parents were sent an informational flyer and consent form in homework folders for a required course on home economics. All but four students were given permission to participate. The students also provided assent. The study was approved and conducted in accordance with the Institutional Review Board's Human Subjects Committee.

Experimental Design

All participants were given an activated Apple iPhone for the duration of the experiment. Participants were individually assigned randomly to one of three conditions in the experiment: (1) the positive and negative feedback condition (Pos/Neg), (2) the positive or neutral only feedback condition (Pos-Only), and (3) the control condition (No-Pet). All participants were sent daily reminder e-mails at 7 a.m., requesting that participants use their phone to take a photograph of their breakfast and send it back.

Virtual-pet conditions. During the course of the experiment, participants assigned to the Pos/Neg condition and the Pos-Only condition selected and interacted with a pet of their choice (described in detail later). Their morning e-mails came from the pet and their photographs of breakfast were sent back to the pet. Participants in the Pos/Neg condition were provided with both positive and negative visual expressions of feedback on their breakfast behaviors directly from their pet, meaning that their pet could vary across five visual depictions from ecstatic to distraught, as depicted in Figure 1 ($n = 12$). Those who were assigned pets in the Pos-Only condition were provided with positive to neutral visual feedback, so the pet's responses ranged between elation and neutral, but never expressed sadness or looked distraught ($n = 13$).

To specifically test visual feedback, textual feedback was held constant across the Pos/Neg and Pos-Only conditions. If participants skipped breakfast, textual feedback they received from their pet was equal, i.e. "I didn't get breakfast this morning so I don't have much energy today."

No pet condition. Participants in the no pet control condition ($n = 14$) received the same exact daily e-mails as the two treatment conditions, though the e-mails came from a generic e-mail address instead of from a pet. Participants in this control condition did not choose a pet or interact with a pet in any way, nor did they receive any feedback on their breakfast. These teens simply took photos of breakfast and sent the photo in to the project e-mail. They were never sent any requests to eat healthily or any explicit suggestion that it is healthy to eat breakfast.

Stimulus Material

We tested our research questions using a virtual pet care game in the style of the popular Tamagotchi or Nintendogs, designed to run over the Internet on smartphones and

FIGURE 1
All five stages of feedback (Condition 1)

other mobile devices with web-browsing capabilities. In the game, the player first adopts and names a pet, choosing from a variety of possibilities including a dog, dinosaur, penguin, potato, stapler, robot, tree, worm, and hippo. Once the players have adopted a pet, they can "visit" the pet at any time by launching an icon on their phone's home screen. During game play, users receive an e-mail from their pet each morning, prompting them to eat breakfast. Prompts included messages such as "Don't forget to eat breakfast this morning!" Each morning, players are expected to use their phone's built in camera to take a photograph of their breakfast, which is then sent to a research server.

Procedure

Two weeks before the intervention, our research team visited the school to introduce the project and collect pretest self-report measures. Participants were removed from class and completed a short paper and pencil questionnaire. The questionnaire included an eating disorder diagnostic tool in order to screen out participants who might use the game to promote disordered eating (Garner, Olmstead, & Polivy, 1983), but none of the participants was deemed to be at risk of having an eating disorder.

Two weeks later, all of the participants were given an iPhone and trained on how to use the basic features. They were told that the phones were not allowed out during school hours. They were also informed that by the end of the project, they would all eventually participate in every part of the game and that it was important not to talk to their friends about the part of the game they were currently playing at any time. Then, participants were individually trained in a quiet space on their specific "job" as per their assigned condition. The adolescents performed their "job" according to their assigned experimental conditions for 9 days in total. At the end of 9 days, participants were given the posttest (self-report questionnaire) collected on laptop computers via MEDIALAB software. After the posttest was completed, the participants rotated through the other conditions of the experiment, as promised.

Measures

Behavioral measures of breakfast intake. Based on the pictures of breakfast foods that participants were asked to send through the e-mail system, two scores were established on breakfast intake. The first variable measured was the main outcome of interest, the likelihood of eating breakfast at all during the experiment ($M = 0.33$, $SD = 0.30$). This variable was calculated by dividing the number of breakfasts eaten during the experiment by the number of days. The participants ate between 0 and 8 breakfasts during the 9-day study ($M = 3.26$, $SD = 2.95$) with a tendency to not eat on weekends.

An additional variable was created to measure the healthiness of the breakfasts overall. All photos were scored twice by trained undergraduate researchers majoring in nutrition and information science. The intercoder reliability was appropriate (Kappa = .98). In the few cases of disagreement, a third coder's evaluation served as a tiebreaker. Responses were sent to the phones of participants with pets within one hour of the photo being received. Our main interest was in determining if we could promote eating breakfast more often (Rampersaud et al., 2005). However, we also judged the photos based on a rubric based on the healthfulness of the food consumed. A score ranging from -2 (no

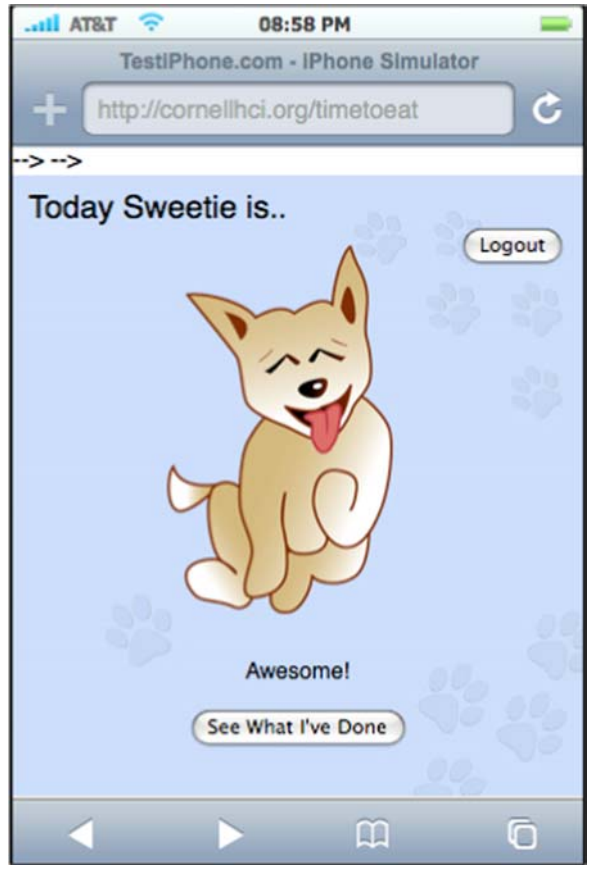

FIGURE 2
Screenshot of feedback on screen

photo submitted) to + 2 (a healthy meal) was awarded to each breakfast that was submitted to us. Scores were based on Consumer Reports Health (2008).

Based on the score, the player's pet responds to an algorithm that causes the user's pet to appear very unhappy, mildly unhappy, neutral, mildly happy, or very happy (see Figure 1). Once the meal is judged, the player receives e-mail feedback from his pet and is prompted to once again "visit" the pet to see the outcome (Figure 2).

Attitudes toward pet. The following variables were measured upon completion of the 9-day experimental period. Measures referring specifically to the pet were only given to participants with pets. All other measures were given to all participants.

- *Attachment to pet* Using 5-point scales (1 = "strongly disagree," 5 = "strongly agree"), all participants who played the pet game rated the degree to which the pet comforted them by completing a version of the Comfort from Animals Companion Scale (Zasloff, 1996) that had been slightly modified to reference the virtual pet ($\alpha = .98$, $M = 3.29$, $SD = 1.29$). The 11-item scale was constructed from a series of questions such as "my pet is fun, my pet

makes me feel needed, and my pet is always there for me" that were measured on 5-point scales (1 = "strongly disagree," 5 = "strongly agree").

- *Motivation to help pet* Two items measured how motivated participants were to help their pet. Items were measured on a 5-point scale and measured how much participants wanted to make the pet happy ($M = 3.72$, $SD = 1.46$), and avoid seeing it become sad ($M = 3.20$, $SD = 1.53$). The items were highly correlated and therefore combined to form one variable of motivation to help pet, with higher scores indicating more motivation to help ($r = .84$, $M = 3.46$, $SD = 1.38$).

Self-efficacy. Personal efficacy to eat healthily was measured with 10 items modified from the Project EAT Survey (Neumark-Sztainer, Story, Hannan, Perry, & Irving, 2002) ($\alpha = .78$, $M = 3.01$, $SD = 0.64$). The scale included such questions as "For the past two weeks, how difficult would it be to eat healthy if you were with friends?" Higher scores indicated agreement with statements, with 1 indicating "very hard" and 5 indicating "very easy."

In the two conditions of the experiment where participants were assigned to play the virtual pet game, participants also responded to one item directly measuring self-efficacy in regards to caring for their pet ($M = 3.20$, $SD = 1.32$). Higher scores indicated higher self-efficacy, with 1 indicating "strong agreement" and 5 indicating "strong disagreement." The reverse-coded item read: "It was hard to keep my pet happy."

Perceptions of Importance of Eating Healthily

Perceived value of healthy eating in general was assessed by asking participants to use a 5-point scale (1 = "don't care at all," 5 = "care very much") to rate how much they care about eating healthily (Neumark-Sztainer et al., 2002). A higher score indicated "caring a lot" and a lower score indicated "not caring at all" ($M = 3.60$, $SD = 1.13$).

Attitudes toward Intervention

Recall that participants were asked to complete a specific "job" associated with their assigned condition. Enjoyment of "job" was measured on an 8-item scale, including items such as "I enjoyed doing my job" and reverse-coded items such as "My job was boring" ($\alpha = .92$, $M = 3.18$, $SD = 0.97$). Effort expended toward succeeding at job was measured on a 6-item scale; items included "I put a lot of effort into this job" and reverse-coded items such as "I didn't try very hard at my job" ($\alpha = .83$, $M = 3.43$, $SD = 0.99$). Perceptions of how skilled one judged oneself at the job were measured on a 6-item scale with items such as "I was good at my job" and reverse-coded items such as "This was a job I couldn't do very well" ($\alpha = .88$, $M = 3.18$, $SD = 1.06$). Sustained interest in job was measured with one statement asking if the participant had lost interest in his or her job after a few days and was reverse coded to indicate sustained interest ($M = 3.38$, $SD = 1.39$).

Results

Likelihood to Eat Breakfast

A one-way Analysis of Variance (ANOVA) revealed differences between conditions on the likelihood of eating breakfast, $F(2, 36) = 4.52$, $p < .05$, $\eta_p^2 = .20$ (Table 1). Those in the

TABLE 1
Means by condition

	a Pos/Neg *M* (*SD*)	b Pos-Only *M* (*SD*)	c No Pet (photo only) *M* (*SD*)
Likelihood to Eat Breakfast	0.52 (0.20)^{b*c**}	0.27 (0.28)^{a*}	0.20 (0.31)^{a**}
Breakfast Healthiness	1.12 (0.46).	1.19 (0.27)	1.15 (0.46)
Pet Attachment	3.81 (0.92)^{b*}	2.80 (1.41)^{a*}	n/a
Motivation to Help Pet	4.08 (0.85)^{b*}	2.88 (1.55)^{a*}	n/a
Self-Efficacy to Eat Healthily	3.15 (0.45)	2.92 (0.86)	2.96 (0.57)
Perceived Pet Care Efficacy	2.67 (1.15)^{b*}	3.70 (1.32)^{a*}	n/a
Importance of Eating Healthily	4.17 (0.58)^{b**}	2.85 (1.41)^{ac**}	3.79 (1.41)^{b**}
Enjoyment	3.55 (0.86)^{b*}	2.63 (1.00)^{ac*}	3.37 (0.84)^{b**}
Sustained Interest	3.83 (0.83)^{b**}	2.31 (1.32)^{ac**}	4.00 (1.30)^{b**}
Reported Effort	3.83 (0.83)^{b*}	2.31 (1.32)^{ac**}	3.63 (0.95)^{b**}
Reported Skillfulness	3.70 (0.77)^{b*}	2.58 (1.06)^{ac**}	3.30 (1.05)^{b**}

$*p < .05$; $**p < .01$. Superscripts indicate significant differences across columns

Pos/Neg condition were about twice as likely to eat breakfast ($M = 0.52$, $SD = 0.20$), than those in the Pos-Only condition ($M = 0.27$, $SD = 0.28$, $p < .05$) and participants who sent pictures in but did not have pets ($M = 0.20$, $SD = 0.31$, $p < .01$). Therefore, Hypothesis 1 was supported, but only for those participants who received both positive and negative feedback.

Healthiness of Breakfast when Eaten

In examining the healthiness of the breakfasts eaten by those teens who did eat breakfast, a one-way ANOVA revealed no differences between conditions on healthiness of the breakfasts, $F(2, 24) = 0.11$, $p = .89$, $\eta_p^2 = .009$. When participants did eat breakfast, those in the Pos/Neg condition were no more likely to eat a healthy breakfast ($n = 12$, $M = 1.12$, $SD = 0.46$), than those in the Pos-Only condition ($n = 9$, $M = 1.19$, $SD = 0.27$) or participants who sent pictures in but did not have pets ($n = 6$, $M = 1.15$, $SD = 0.46$).

Attachment and Motivation

The following analyses were designed to assess attitudes toward pet-specific concepts and *t*-tests were performed as independent-samples paired comparisons between participants in the conditions with pets only.

Attachment to pet. Analysis revealed that those in the Pos/Neg condition were more attached to their pets ($M = 3.81$, $SD = 0.92$) than were those in the Pos-Only condition ($M = 2.80$, $SD = 1.41$), $t = 2.11$, $df = 23$, $p < .05$, $d = 0.86$.

Motivation to help pet. Those in the Pos/Neg condition reported being more motivated to help their pet ($M = 4.08$, $SD = 0.85$) than were those in the Pos-Only condition ($M = 2.88$, $SD = 1.55$), t(unequal variances) $= 2.42$, $df = 18.84$, $p < .05$, $d = 0.95$.

Self-Efficacy

Eating self-efficacy. Comparing across the three conditions, there were no differences on participant reports of personal self-efficacy to eat healthily, $F(2, 36) = 0.44$, $p = .65$, $\eta_p^2 = .02$.

Pet-care efficacy. *T*-test analysis revealed that those in the Pos-Only condition, assigned to pets responding only with happy or neutral states, found it easier to care for their pet ($M = 3.70$, $SD = 1.32$) than those in the Pos/Neg condition ($M = 2.67$, $SD = 1.15$), $t = 2.06$, $df = 23$, $p < .05$, $d = 0.83$.

Importance of Eating Healthily

A one-way ANOVA was conducted to detect differences between conditions on perceptions of how much the participants care about healthy eating, $F(2, 36) = 5.86$, $p < .05$, $\eta_p^2 = .23$. Post hoc tests revealed that those in the Pos-Only condition ($M = 2.85$, $SD = 1.41$) reported caring less about healthy eating than participants in the other two conditions; that is, those in the Pos/Neg condition ($M = 4.17$, $SD = 0.58$), $p < .01$, and those that sent pictures without a pet ($M = 3.79$, $SD = 1.41$), $p < .05$.

Attitudes toward the Intervention

Due to zero-order correlations across dependent variables of interest (all above $r = .50$, but below $r = .70$), a multivariate ANOVA was conducted to detect differences between conditions on attitudes toward participants' assigned intervention/manipulation. A significant effect was found for condition on enjoyment, effort, skill, and sustained interest in job $F_{Wilk's}(8, 68) = 2.11$, $p < .05$, $\eta_p^2 = .20$. Subsequent between-subjects ANOVA and post hoc tests were examined to detect differences and patterns between conditions on attitudes toward their "job."

Enjoyment. Participants in the Pos-Only condition ($M = 2.63$, $SD = 1.00$) reported that they enjoyed their job less than participants in the Pos/Neg condition ($M = 3.55$, $SD = 0.86$), $p < .05$, or in the control condition did ($M = 3.37$, $SD = 0.84$), $p < .05$, $F(2, 36) = 3.01$, $p < .05$, $\eta_p^2 = .17$.

Sustained interest. Those in the Pos-Only condition ($M = 2.31$, $SD = 1.32$) reported that they were less able to hold interest in their job than participants in the Pos/Neg condition ($M = 3.83$, $SD = 0.83$), $p < .01$, or in the control condition ($M = 4.00$, $SD = 1.30$), $p < .01$, $F(2, 36) = 8.13$, $p < .01$, $\eta_p^2 = .31$.

Effort. Participants in the Pos-Only condition ($M = 2.82$, $SD = 0.93$) reported expending less effort toward their job than those in the Pos/Neg condition ($M = 3.85$, $SD = 0.80$), $p < .05$, or in the control condition ($M = 3.63$, $SD = 0.95$), $p < .05$, $F(2, 36) = 4.71$, $p < .05$, $\eta_p^2 = .21$.

Skill. Participants in the Pos-Only condition ($M = 2.58$, $SD = 1.06$) reported that they were less skilled at their job than participants in the Pos/Neg condition ($M = 3.70$,

$SD = 0.77$), $p = .057$, or in the control condition ($M = 3.30$, $SD = 1.05$), $p < .01$, $F(2, 36) = 4.26$, $p < .05$, $\eta_p^2 = .19$.

Discussion

In this project, we investigated the effects of a mobile-phone-based virtual pet game in a randomized field experiment. Our primary dependent variable of interest was likelihood to eat breakfast. We found that pets that provided both positive and negative feedback increased the likelihood that the participants would eat breakfast. This technology holds great promise in the area of nutrition and public health, with an emphasis on three key findings: (1) the importance of negative feedback, (2) the appropriate use of computer-based representations of the self in persuasion, and (3) implications for attachment.

The Importance of Negative Feedback

Those who received negative feedback from their pet were twice as likely to eat breakfast compared to their peers who never saw their pet become sad or who did not have a pet at all. Teens with pets enabled to become sad were more motivated to help their pet, were more attached to their pet, enjoyed the game more, reported expending more effort toward the game, thought they were more skilled at the game, maintained a higher level of sustained interest in the game, and felt that eating healthily was more important, when compared to those in the Pos-Only condition. It is especially interesting to note that participants in the Pos-Only condition were less likely to believe that healthy eating is important, compared to participants in the other pet condition and the control. Having a sad pet didn't necessarily do anything to increase the belief that eating healthily is important (at least compared to control), but rather having a Pos-Only pet appeared to have undermined this belief.

All of these results occurred in spite of the fact that teenagers with sad pets reported that caring for their pet was more difficult than those with neutral-happy pets. There were no differences in self-efficacy, meaning that participants with sad pets did not necessarily perceive that it was any easier to eat breakfast—but they did so anyway. These results suggest that designers of health interventions should consider the motivational value of negative feedback, especially in the context of virtual pets.

The Appropriate Use of Computer-Based Representations of the Self in Persuasion

One reason that the Pos/Neg pet may have been the most effective in changing behavior is that it allowed young teenagers to more easily receive and respond to criticism because the consequences of their actions were observable in a form outside the self. Although the pets in this study were not traditional avatars because they are not human representations of the self, this may have been a strength of our study. Our game allowed users to essentially care for themselves in the form of a cute creature. The pet provided negative feedback without criticizing the user directly (i.e. "you are unhealthy"). Teenagers may have eaten breakfast simply to avoid seeing their pet be sad, which motivated new habits and behaviors without direct confrontation to self or identity.

Implications for Attachment

Finally, given that human–pet attachment is sustained by the human instinct to provide for the needs of the animal (Archer, 1997), and that this relationship is often powerful enough to supersede other human–human relationships (Kurdek, 2009), it is not surprising that participants were more attached to the virtual pets when they were exposed to the negative consequences of their eating behaviors on their pets. Providing realistic feedback within the game may have sent the message that the teens can't get away without eating breakfast without causing harm to their pet.

Limitations

There are some methodological limitations in this study that should be addressed in future iterations of this research. First, our study was limited to the effects of using the system for 9 days. It is possible that these effects would be strengthened or taper off over a longer period of time. Future research should examine the effects of the system over multiple months or even years—with intermittent "boosters" to reinforce retention of changed behaviors. Second, it is possible that participants talked to one another and realized the differences between their condition and other conditions. We asked the children to keep their specific "job" a secret and saw no evidence of contamination. However, as with any field experiment in social science, there is potential of contamination. Third, if a participant did not send in a photo, we treated it as not eating breakfast. It is possible that some participants ate but did not send in a photo or, conversely, sent in a photo of food that they never ate. However, random assignment to conditions should have theoretically distributed any participants that were deceptive. Fourth, including multiple analyses as we have done increases the chance that some of our findings can be attributed to error. Each of these analyses was determined a priori and is theoretically relevant to the study, but we must acknowledge that including this number of analyses does not come without some statistical risk. Finally, this study involves a relatively small, homogeneous sample. Although we would assume that these effects should be stable or grow stronger as the sample size increased in number and demographic diversity, future research is necessary to determine that. In particular, it would interesting to examine these effects across different cultural and socioeconomic contexts.

Future Research

Certain additional features may lead to further compliance through both collaboration and competition. Previous studies indicate that public behaviors in digital media are more likely to become integrated into a person's way of thinking about the self (Gonzales & Hancock, 2008). It may also be true that social visibility in the game would increase the likelihood that participants will take on the desired role of being a healthy eater. Features such as competition between individuals or teams, a chat function to facilitate social support, and access to view one another's pet might increase the efficacy of such technology. Results also call for refining how these interventions are conceptualized and labeled. For example, instead of positive and negative feedback, a finer distinction might be "encouraging" and "empathy building." Finally, it would be valuable to test whether this manipulation could be generalized to other behavioral contexts, such as academic performance, and other health behaviors, such as exercise.

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