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Framing Virtual Experiences: Effects on Environmental Efficacy and Behavior Over Time

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Abstract

In virtual environments (VEs), users experience visceral simulations that feel like the real world. Virtual experiences are proposed as a novel operationalization of gain and loss framed environmental messages. A 2 (gain vs. loss frame) × 2 (high vs. low interactivity) × 3 (pretest, posttest, delayed posttest) experiment was conducted. Immediately following exposure, virtual experiences promoted environmental behavior by reducing paper consumption by 25% compared to a control group. In addition, the gain framed experience of growing a virtual tree promoted behavioral intentions more effectively than the loss framed experience of cutting down a tree. Response efficacy mediated the relationship between framing and environmental behavioral intentions. One week after exposure, response efficacy heightened as a result of the gain frame. Participants in the high interactivity conditions also reported higher levels of environmental behavior than those in the low interactivity conditions one week following exposure.

Keywords

virtual environments, framing, interactivity, environmental behavior, response efficacy

One of the greatest challenges faced by scholars of environmental communication is the knowledge-to-action gap, which refers to the lack of actual environmental behavior being carried out despite heightened public awareness of environmental

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problems (Finger, 1994; Kollmuss & Agyeman, 2002). A reason for this disconnect in what individuals know and do may lie in the temporal gap between individual actions and environmental consequences, rendering the connection between cause and effect abstract. For example, wasting paper or not recycling for a few months may not lead to noticeable consequences. Due to the abstraction and absence of immediately perceivable effects, not only do individuals lack a sense of responsibility for environmental problems, but they also lack environmental *response efficacy*, or belief in the ability to improve the environment through their individual behaviors (Cleveland, Kalamas, & Laroche, 2005; Hines, Hungerford, & Tomera, 1987; Rogers, 1975; Smith-Sebasto & Fortner, 1994).

With the proliferation of digital media such as video games and virtual reality, exploring the form of message delivery using different platforms may be just as important as studying message content in constructing messages that best promote environmental behaviors. High levels of interactivity offered by advanced digital media may transform traditional processes of persuasion by allowing users to become physically engaged in the message (Ahn & Bailenson, 2011; Lombard & Ditton, 1997).

To this extent, the current experiment examines a novel interpretation of framing theory by proposing the use of virtual environments (VEs) to present framed experiences, contrasting the effect of vividly positive or negative experiences of future consequences within VEs on the promotion of environmental behavior. In addition to the examination of this main effect of framing, traditional framing theory is expanded in several aspects within the context of environmental communication. First, response efficacy was investigated as a mediator that drives environmental behavior following framed experiences in VEs. In addition, interactivity was manipulated to investigate its potential as a moderator of framing effects. Moreover, given that the practical goal of environmental messages is to affect long-term behaviors, data were collected 1 week before, immediately following, and 1 week after treatment to examine the effect of framed virtual experiences over time and outside of the laboratory.

Framing Virtually Delivered Environmental Messages

Framing refers to the process by which media select and emphasize some aspect of a perceived reality (Entman, 1993; Scheufele, 1999) as well as the process of individuals reorienting their thinking about an issue based on the messages they receive (Chong & Druckman, 2007). The bulk of framing studies have incorporated text-based, semantic manipulations. With the advent of highly interactive multimodal platforms, media consumption patterns have shifted significantly over time but framing research has remained relatively stagnant in exploring framing production in the era of advanced digital media.

Visual Framing Research

Despite the consensus on the importance of visual cues in communication processes including framing (Messaris & Abraham, 2001), there is a relative dearth of research in visual framing. Recently, Scheufele and Iyengar (in press) suggested that applying non-verbal framing cues based on pictorial frames (i.e., framing by varying the presentation of static photographs) could be powerful vehicles of information that may be more relevant to the modern audience than semantic framing cues. One potential advantage of pictorial (vs. semantic) frames suggested was its precision in terms of experimental control, which allows researchers to manipulate a dimension as specific as skin complexion while keeping all other observable dimensions constant. The intended manipulation would be much clearer when presented visually compared to semantic manipulations, which may be open to varying interpretations (Scheufele & Iyengar, in press). Empirically, altering visual frames has been found to have a powerful effect on the perception of news events and political attitudes (Bailenson, Iyengar, Yee, & Collins, 2008; Grabe & Bucy, 2009). In addition, some studies comparing verbal against visual frames found that stipulations of classical framing theories still apply to both platforms, but visual frames were better able to augment health message effects (Schneider et al., 2001).

Visual framing uses techniques and platforms different from verbal framing to operationalize frames, thereby affecting the intensity of framing effects (Coleman, 2010). A textual description of an event may be visually depicted but still retain the content of its original message and vice versa. In much the same way, the study of visual frames does not render the theoretical framework of verbal frames obsolete, but extends the classical understanding of framing effects in non-verbal mediated environments with novel affordances.

Potential for Experiential Framing

Emerging digital media platforms can take the research on visual framing to a new level by framing not just visual cues but also dynamic experiences in VEs. VEs are digitally rendered spaces that blur the distinction between reality and its virtual representation (Blascovich & Bailenson, 2011). Digital devices are able to realistically simulate sensory information so that users are able to see, hear, and feel in the VE as if they are in the physical world. These virtual experiences are far richer than traditional media (Ahn, in press; Ahn, Le, & Bailenson, 2013) and may be more persuasive than semantic or pictorial framing because the message is more vivid and interactive due to a broader spectrum of sensory information.

Despite the bulk of framing research being concentrated on verbal framing, classical definitions of framing—an emphasis of a particular aspect of an event—may be better served by experiential framing within VEs. Recent research in the field of decision-making yield further support to this proposition. Similar information can lead to different choices depending on whether the information was acquired through personal experience or through print description (Hertwing, Barron, Weber, & Erev, 2004; Marx et al., 2007). Personal experience of an event made the information more salient and served as a more significant point of reference than a description of the same event. Thus, experiential framing within VEs extends traditional framing theories by not only applying the concept of framing in a novel mediated environment, but also by potentially increasing the intensity of framing effects via realistic simulations of the emphasized aspect.

Heightened intensity of framing effects is particularly relevant for issues such as environmental behaviors in which there are inherent psychological distances between the self and the problem. That is, environmental problems often seem temporally distant in that negative consequences take a relatively longer time to manifest, as well as socially distant in that environmental issues seem to affect society as a whole rather than an individual. Weber (2006) argued that these psychological distances lead to an underestimation of the severity of environmental problems and argued that scholars needed to find ways to evoke visceral reactions toward environmental problems, perhaps by simulations of concrete future consequences, to encourage environmental behaviors.

Virtual frames offer just that kind of experiential framing, wherein the benefit of compliance or the consequence of non-compliance is not merely a scenario on a page, but rather a vivid, interactive event that can be personally experienced. That is, rather than simply reading a print message that states, “If you do not save paper, you are contributing to deforestation,” the user may enter a three-dimensional virtual forest and experience cutting down the tree with a chainsaw to enact the detrimental consequences of failing to conserve paper. The same conservation message may also be presented as a potential gain: The effect of successfully conserving paper can be experienced by the user by nurturing a virtual tree into maturity without cutting it down to produce paper.

Furthermore, earlier studies on environmental behavior have noted that individuals who cannot envision the future consumed significantly more natural resources compared to those who were able to think about the future (Zimbardo & Boyd, 2008). Because VEs provide a “fast-forwarded” experience of future consequences during which individuals would be able to cut or grow a tree as a result of their current actions, the loss or gain that the framed message is attempting to highlight is expected to be much more lucid than semantic or static pictorial cues. As this is the first exploration of framed experiences in VEs to the best of our knowledge, an initial comparison against a true control condition is necessary to assess the effect of treatment in contrast to the baseline. Due to the intensified sensory experience within VEs, framed virtual experiences are expected to be more effective in promoting immediate paper conservation behavior compared to not receiving any treatment at all (Hypothesis 1 [H1]).

Framing Environmental Messages

Exploring framing for such topics as environmental issues may be distinct compared to more traditional framing research. Whereas traditional framing investigates the shift in perceptions and opinions as a result of a particularly framed news article, framing research in the context of health or environmental communication has a clear goal of encouraging compliance. One type of message frame, gain and loss framing, explores the use of frames to modify behavior and is relevant to studying effects of environmental frames.

The basic premise of gain and loss framing research is borne from the science of decision-making, which finds that individuals react differently to messages that present the same outcome framed as either potential gains or potential losses (Kahneman & Tversky, 1979). Communication scholars have applied this perspective to examine the persuasiveness of messages focusing on the advantage of compliance (i.e., gain framing) or the disadvantage of non-compliance (i.e., loss framing; e.g., Rothman & Salovey, 1997). Both frames promote the same end goal; the research interest lies in determining which approach will better promote the desired behavior. The bulk of gain and loss framing research has been concentrated in the area of health communication, another area where behavioral compliance is a critical measure of success (O'Keefe & Jensen, 2006; Shen & Dillard, 2007).

There has been limited research on the general framing of environmental messages (e.g., Hart, 2011; Tewksbury, Jones, Peske, Raymond, & Vig, 2000), but few studies have explored gain and loss framing effects within the context of environmental issues. The limited evidence available tentatively suggests a relative advantage of gain frames over loss frames in the environmental context. For instance, gain frames were found to be more effective in eliciting environmental intentions when the environmental issue at hand was made salient (Obermiller, 1995). In another study, when climate change was framed as having potential health consequences, participants responded more positively to a gain frame (health benefits) than a loss frame (health risks; Maibach, Nisbet, Baldwin, Akerlof, & Diao, 2010). Gain framed messages also successfully promoted the intention to engage in environmental behavior when the message reflected high uncertainty of environmental damage (Morton, Rabinovich, Marshall, & Bretschneider, 2011).

Thus, within the context of an environmental message, gain frames are expected to elicit greater environmental behavioral intentions (Hypothesis 2a [H2a]) and behavior (Hypothesis 2b [H2b]) immediately after exposure to the framed message compared to loss frames.

Constructing Virtually Framed Gain and Loss Experiences

Two distinct approaches in the construction of gain and loss frames can be found in prior literature. One is to stay true to the original conceptualization of framing as presented by Kahneman and Tversky (1979) by presenting two distinct outcome choices with equivalent expected values, wherein the content is formally equivalent (Rothman & Salovey, 1997). The other is to manipulate the actual content conveyed in the two messages to highlight gains or losses. For example, a recent experiment using videos explored the effect of gain and loss framing on breast cancer screening by showing different contents featuring only the benefits of screening to one group of participants and only the losses of not obtaining a screening to the other (Kim, 2012).

Constructing a virtually framed gain or loss experience stands at the middle of these two approaches due to VEs' capacity to delineate identical environmental contexts while emphasizing one particular aspect of the experience. Individuals may visit identical virtual forests to experience contextually equivalent sensory information (e.g., looking around the three-dimensional view of the forest, listening to ambient sounds). However, the gains of engaging in environmental behaviors may be accentuated with an interactive experience of growing a tree, and the losses of not engaging in environmental behaviors may be accentuated with an interactive experience of cutting down a tree. This emphasis, although still occurring within the same virtual forest, is qualitatively different and is likely to impact the overall experience, framing it as either a gain or a loss.

The Effect of Framing Virtual Experiences Over Time

According to Baden and Lecheler (2012), "The social relevance of framing effects hinges upon their ability to persist" (p. 1). Particularly for experimental studies, if framing effects tested within the controlled laboratory environment do not last, the contribution of this research to practical applications is limited. The duration of effects may be particularly relevant when the experimental stimulus is presented in a VE—even if immediate effects are measured, the influence of virtual experiences may be transient in the physical world.

To date, only a handful of experimental studies have looked at the duration of framing effects over time (cf. de Vreese, 2004; Lecheler & de Vreese, 2011, 2013; Tewksbury et al., 2000). In one of the first proposed theoretical frameworks on the persistence of framing effects, Baden and Lecheler (2012) suggested that framing shifts an individual's perception of an event or an issue by activating accessible and available beliefs in the individual's mind and, as a result of the framed message, influencing and reorganizing the cognitive structure. Framing effects that merely stop at activating accessible and available beliefs are thought to be temporary and short-lived, whereas framing effects that are able to influence the cognitive structure of the mind by creating and integrating new belief structures are thought to persist over time. An earlier experimental study demonstrated that the effect of framing, when moderated by individual differences in prior knowledge, could last for up to 2 weeks following experimental exposure (Lecheler & de Vreese, 2011).

Using this line of logic, VE messages are anticipated to create new belief structures by allowing users to experience novel events that are difficult to replicate in the physical world. That is, because the experience of growing a tree to maturity or cutting down a tree is likely novel to most individuals, it is expected to create new belief structures based on the virtual experience that will integrate with existing belief structures about conservation behaviors. There have been few studies examining the effects of VE exposure over time, suggesting that virtual experiences may be powerful enough to influence attitudes and behavior up to 24 hours following exposure (Ahn et al., 2013; Fox & Bailenson, 2009). However, not many studies to date have employed systematic investigations of the longer term effects of VEs and fewer studies, if any, have looked at the longer term effects of framed virtual experiences. As one study noted that certain framing effects did not manifest until 1 week following exposure (Lecheler & de Vreese, 2013), the current study aims to explore how the effects of framed virtual experiences observed in H2a and H2b change over 1 week following exposure to the VEs. That is, will gain framed virtual experiences still be more effective than loss framed virtual experiences in increasing environmental behaviors 1 week following exposure (Research Question [RQ1])?

Response Efficacy as a Mediator of Environmental Behavior

We anticipated that gain frames would be more effective in promoting environmental behavior compared to loss frames, but perhaps a more interesting question is why. Previous research shows that a key element that drives environmental behavior is environmental response efficacy. The concept was originally developed within the context of health behavior promotion (Rogers, 1975), but environmental studies have also demonstrated that when individuals feel that partaking in recommended behaviors directly influences the wellbeing of the environment, they are more likely to be concerned about and actively care for the environment (Cleveland et al., 2005; Lam, 2006).

In addition, experience of personal success at a task has been found to be the greatest motivator in the confidence to carry out those behaviors (Bandura, 1997). Hence, the personal experience of nurturing a seedling into a mature tree in the gain framed VE is expected to help the individual recognize the connection between individual actions and environmental benefits, thereby increasing the perception of environmental response efficacy. Heightened efficacy, in turn, has often been confirmed as one of the strongest predictors of behavior in environmental behaviors (Hines et al., 1987).

Few studies have investigated the role of response efficacy as a mediator, particularly for environmental behavior. One study exploring gain or loss framed messages on anti-speeding messages found that response efficacy served as a mediator for gain framed messages but not for loss framed messages (Lewis, Watson, & White, 2010). Other studies looking at the mediating role of efficacy found that when environmental messages elicit greater perceptions of efficacy, it ultimately leads to greater intentions for environmental behaviors (White, MacDonnell, & Dahl, 2011). In the context of framing, Morton et al. (2011) found that perceptions of efficacy mediated the effect of a framed textual message about climate change on behavioral intentions. When participants were given gain framed messages that described an uncertain situation, it led to greater perceptions of environmental efficacy and ultimately the intent to engage in environmental behavior. Loss framed messages elicited the opposite effect by reducing environmental efficacy.

Taken together, we may posit that the increase in response efficacy following the gain framed VE experience will lead to greater behavioral intentions than the loss framed experience, mediating the relationship between framing and behavioral intentions immediately following the treatment (Hypothesis 3 [H3]). As longer term effects may occur from the framed experience, this meditational role will also be assessed 1 week following the treatment (Research Question [RQ2]).

Interactivity as a Moderator of Framed Virtual Experiences

If response efficacy is explored as the mechanism of framed virtual experiences, interactivity will be explored as an element of VEs that may moderate framing effects. VEs are often distinguished from other media due to their high levels of *interactivity*, the process in which the user can influence the form or content of the mediated experience (Lombard & Ditton, 1997). There are various benefits of higher levels of interactivity, such as greater audience involvement (Fortin & Dholakia, 2005), greater perceived realism (Ahn et al., 2013; Fox, Bailenson, & Binney, 2009), and higher levels of favorable attitude change (Sundar, Kalyanaraman, & Brown, 2003).

Framing research has often concentrated on individual differences such as sex (Kim, 2012) as moderators that may condition framing effects. Lecheler, de Vreese, and Slothuus (2009) noted that contextual variables are also important moderators to consider when evaluating framing effects. In the context of a VE, one key variable is the level of interactivity that a user can experience with the virtual message.

Following Sundar's (2004) suggestion, interactivity in the current study will be defined as the VE's affordance in providing real-time feedback and responses to the user's input. An example of low level interactivity would be a typical desktop computer setup, wherein users can only interact with a message using the clicks and movements of a mouse. A highly interactive environment would be a VE setup, wherein the equipment enables users to engage in the message using naturally mapped body movements (in this study, being able to pump water or saw a tree by moving a device back and forth with their hands in the same motions they would use in the real world) and receiving natural feedback (such as the vibrations of the saw or pump). These contextual differences are expected to influence the effect and strength of framed experiences because interactivity levels influence information processing, yielding differing levels of cognitive activity and involvement (Fortin & Dholakia, 2005; Sundar, 2004).

Very few studies have employed VEs to investigate environmental issues, but an earlier study on emergency preparedness (Zaalberg & Midden, 2010) used an interactive virtual simulation of flooding, purportedly a result of global warming. Participants who interacted with the simulation were more aware of emergency preparedness compared to those who saw a slideshow on flooding. Furthermore, in an forthcoming rendition of this work (Ahn, Bailenson, & Park, in press), the interactive experience of cutting down a tree in a VE led participants to consume 20% less paper compared to those who merely read about cutting down a tree. Thus, having a high level of control and feedback while either cutting or growing a tree in the VE is likely to amplify framing effects on environmental behaviors. That is, immediately following the virtual experience, gain framed experiences with high interactivity are anticipated to lead to higher environmental behavioral intentions compared to gain framed experiences with low interactivity. As depicted in Figure 1, the effect of framing on environmental behavioral intentions is expected to be contingent on the level of interactivity during the framed experience (Hypothesis 4 [H4]). The effect of interactive experiences is

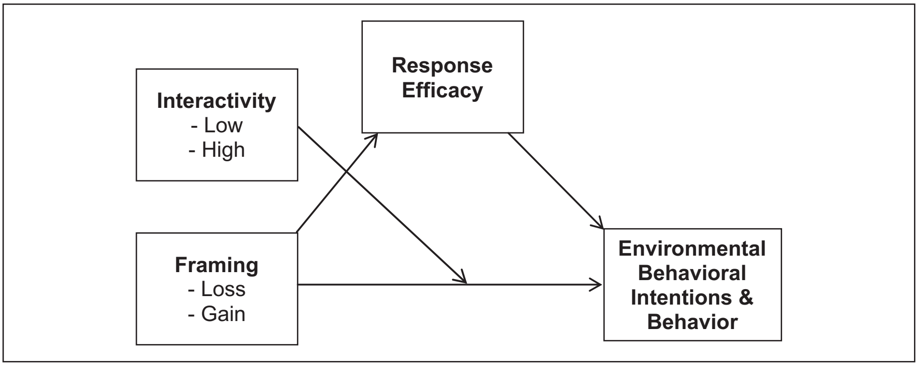

Figure 1. Hypothesized model of direct effect moderation.

anticipated to persist for up to 1 week following experimental treatments, and the change in the combined effect of interactivity and message framing will also be assessed 1 week afterward to examine effects on behaviors following the laboratory experiment (Research Question 3 [RQ3]).

Method

This study employed a 2 × 2 × 3 mixed factorial design, whereby framing (gain vs. loss) and interactivity (low vs. high) were crossed between subjects and measurements were assessed at three different time points spaced at least 1 week apart. A separate control condition with no VE treatment was also included to assess the baseline level of observed environmental behavior.

Sample

A convenience sample was obtained from the student populations of two large universities in the Midwest and the South. The sample (N = 114) consisted of 80 women and 34 men, aged 18 to 32 (M = 20.80, SD = 2.05). To control for possible variance due to experimental setup, all equipment, programs, supplies, and procedural details were identical at both experimental sites. Furthermore, baseline measurements for all dependent variables were assessed and compared across both institutions to ensure equivalence of the two samples and the process was repeated at each stage. No significant differences between the two groups were found in any of these tests, and study location is not discussed further.

Stimuli

Figure 2 depicts the experimental setup and equipment. In the high interactivity conditions, a Novint Falcon haptic device allowed participants to feel objects in the VE by

Figure 2. Experimental setup.
Note. Participants in the low interactivity condition (A) passively watched a tree being cut or grown in the virtual forest. In the high interactivity condition (B), they used the haptic device (C) to actively cut or grow a tree in the virtual forest.

providing mechanical resistance and realistic vibrations as the participant controlled the chainsaw or water pump.

In the cut high interactivity condition, the participant entered the virtual world in the first-person perspective. They were first asked to look around the forest using the mouse to control their viewpoint in the world, taking in the sky, the audibly chirping birds, and the plants. Participants looked down to see they were holding a chainsaw. They heard and felt the chainsaw start, and were instructed to begin moving the haptic device back and forth to cut the tree in front of them down. The program required all participants to engage in cutting motions for 2 minutes. After 2 minutes, participants saw and heard the tree crash down to the ground, and the forest became quiet to emphasize the damage.

In the grow high interactivity condition, the participant was standing in front of a seedling in a quiet forest, holding onto the handle of a pump. Participants then heard and felt the pump start, and were instructed to begin moving the haptic device back and forth (in the same motion as the cut high interactivity condition) to pump nutrients and water to the seedling to help it grow. The program required all participants to engage in pumping motions for 2 minutes. During the 2 minutes, participants saw and heard the seedling grow into the same full-grown tree presented in the cut high interactivity condition. When the growing stopped, participants could hear birds chirping to emphasize the benefits to the forest. Figure 3 depicts the series of events in the virtual forest.

In the low interactivity conditions, the visual and auditory stimuli were identical to the high interactivity conditions, but participants were only able to control the viewpoint with the mouse. During the 2 minutes of tree-cutting or water-pumping, participants watched the process on the monitor without any control of the saw/pump or haptic feedback.

Figure 3. Screenshot of the series of events in the virtual forest.
Note. Participants entered the virtual forest in the first-person perspective (A). In the cut condition, a chainsaw cut the large tree in front of them (B). Participants either actively moved the chainsaw with the haptic device or passively watched the chainsaw moving (C) until the tree crashed to the ground (D). Participants in the grow condition began with a seedling (E) that continued to grow (F) as they pumped water and nutrients to the seedling (G). At the end, they saw the fully mature tree that participants in the cut condition initially saw (H).

Procedure

The experiment was conducted in three different phases. At Time 1, participants completed an online pretest to measure baseline levels of environmental response efficacy. Approximately 1 week later at Time 2, participants came into the laboratory. Upon arrival, participants were randomly assigned to control (n = 21), cut high interactivity (n = 26), cut low interactivity (n = 21), grow high interactivity (n = 25), or grow low interactivity (n = 21) conditions.

Participants in treatment conditions heard information about paper consumption and how it leads to deforestation. They engaged in the VE. Next, they completed survey items. As research indicates discrepancies between self-reports and observations of "green" behavior such as recycling (Bowman, Goodwin, Jones, & Weaver, 1998), actual levels of paper consumption for participants in all conditions were observed with a veiled behavioral measure (i.e., the number of napkins used to clean up an "accidental" water spill initiated by the experimenter; see Ahn et al., in press). Thus, after the completion of the survey, all participants (including those in the control condition) were seated at a table and asked to fill out an information sheet. During this process, the experimenter leaned across the table and knocked over the cup of water with a clipboard, ostensibly by mistake. The experimenter then asked each participant for help and handed a pre-counted stack of paper napkins to the participant before stepping out of the room. After 2 minutes, the experimenter returned, collected the information sheet, and dismissed the participant. After the participant left, the experimenter counted the number of napkins used.

Because environmental behaviors are often recognized and promoted as prosocial and desirable, an obvious behavioral measure that sensitizes participants about its purpose may elicit social desirability biases. The same covert behavioral measure was tested in earlier studies (Ahn et al., in press) and revealed that personally experiencing the negative consequence of paper consumption by cutting down a tree in a VE led to 20% less napkin use compared to reading a print description of the same consequence. Exactly 1 week following Time 2, all participants were emailed the delayed posttest (Time 3).

Measures

Environmental response efficacy. Ten items from the Environmental Action Internal Control Index (Smith-Sebasto & Fortner, 1994) assessed participants' environmental response efficacy. Participants answered on a 5-point interval scale (1 = *does not describe my point of view well*; 5 = *describes my point of view very well*) the extent to which they agreed to statements that describe how individual actions can improve the environment (e.g., "My individual actions would improve the quality of the environment if I were to buy and use recycled paper products.") The measure was administered at all three time points to determine a baseline, short-term effects, and long-term effects. Reliability was high with a Cronbach's alpha of .88 at Time 1, .90 at Time 2, and .90 at Time 3.

Environmental behavioral intentions and self-reported behaviors. Four items assessed relevant environmental behaviors, such as purchasing a recycled paper product and talking to others about recycling. Immediately following the stimulus at Time 2, participants were asked their intentions to engage in these behaviors; 1 week later at Time 3, participants were asked to self-report if they had actually engaged in those behaviors in the past week. The items were fully labeled 5-point Likert scales (1 = *never*; 5 = *very often*) with a Cronbach's alpha of .80 at Time 2 and .75 at Time 3.

Napkins. At Time 2, the number of napkins used to clean up the spilled water was counted as an inverse measure of environmental behavior.

Results

Effect of Gain and Loss Framed Virtual Experiences

H1, H2a, H2b, and RQ1 addressed the effect of gain and loss framed experiences on behavioral intentions and observed behavior immediately and 1 week following experimental treatments. Table 1 provides means and standard deviations for all measures.

Immediate effects. First, an analysis of variance (ANOVA) was run with condition as the independent variable and the number of napkins as the dependent variable. Different experimental conditions led to a significant difference in the number of napkins used, $F(1, 99) = 5.42$, $p = .01$, $\eta^2 = .10$, and a post hoc test using Tukey's HSD (honestly significant difference) revealed that significantly more napkins were used by participants in the control condition compared to those in both grow and cut conditions. Thus, framed virtual experiences succeeded in promoting environmental behavior immediately after exposure, and H1 was supported.

Next, a univariate ANOVA was run with framing as the independent variable and environmental behavioral intentions as the dependent variable. Gain framed experiences elicited greater environmental behavioral intentions than loss framed experiences, $F(1, 91) = 4.77$, $p = .03$, $\eta^2 = .05$, confirming H2a. Next, an ANOVA was run with framing as the independent variable and the number of napkins as the dependent variable. Framing did not predict the number of napkins used, $F < 1$, $p = .56$, and H2b was not supported.

Delayed effects. To address RQ1 and examine the change in behavioral intentions (Time 2) and self-reported behavior (Time 3), a repeated measures ANOVA was conducted with framing as the between-subjects factor, time as the within-subject factor, and behavioral intentions at Time 2 and self-reported behavior at Time 3 as the within-subject variables. There was a significant shift between the behavioral intentions at Time 2 and self-reported behavior at Time 3, $F(1, 88) = 23.24$, $p = .001$, $\eta^2 = .21$. No other effects were significant. Although gain frames elicited higher levels of behavioral intentions compared to loss frames at Time 2, effects from both gain and loss frames decreased at Time 3 to a point where there was no meaningful difference in self-reported environmental behavior between the two types of frames.

Table 1. Descriptive Statistics for Dependent Measures: Means (Standard Deviations).

		Time 2	Time 2	Time 2	Time 2	Time 3	Time 3	Time 3	Time 3
	Time 1	Cut	Grow	High	Low	Cut	Grow	High	Low
Response efficacy	3.42 (0.81)	$3.16 (0.74)_a$	$3.63 (0.87)_b$	3.35 (0.87)	3.45 (0.80)	$2.94 (0.81)_c$	$3.59 (0.89)_d$	3.30 (0.91)	3.22 (0.90)
Napkins	$13.00 (5.44)_a$	$10.00 (3.29)_b$	$9.53 (3.83)_b$	$9.82 (3.07)_b$	$9.68 (4.01)_b$	—	—	—	—
Behavioral intentions	—	$2.63 (0.58)_a$	$2.91 (0.63)_b$	$2.64 (0.65)_e$	$2.87 (0.57)_f$	—	—	—	—
Self-reported behavior	—	—	—	—	—	2.38 (0.56)	2.54 (0.81)	$2.30 (0.79)_e$	$2.59 (0.57)_f$

Note. Means and standard deviations within each row with no subscript in common significantly differ statistically. Subscripts a, b, c, and d denote statistically significant differences for the main effect of framing whereas e and f denote statistically significant differences for the main effect of interactivity.

Table 2. Regression Weights, Indirect Effects Showing Mediation, Bootstrap 95% CI, Lower and Upper Bounds.

			Bootstrap 95% CI	
Regression weights	Coefficient	*SE*	Lower	Upper
Direct effects				
Framing → Response efficacy**	.47	.17	.141	.806
Response efficacy → Intentions**	.43	.06	.302	.556
Framing → Intentions	.15	.15	−.159	.454
Interactivity → Intentions*	.34	.15	.050	.624
Framing × Interactivity intentions	−.13	.21	−.541	.274
			Bootstrap 95% CI	
	Effect size	Bootstrap *SE*	Lower	Upper
Indirect effects				
Framing → Response efficacy → Intentions*	.20	.08	.071	.403

Note. Bootstrap resampling = 1000. CI = confidence interval.
*p < .05. **p < .01.

Direct Effect Moderation Analyses With Interactivity as Moderator

H3, H4, RQ2, and RQ3 addressed the role of interactivity as an overall moderator (0 = *low*, 1 = *high*), in addition to the mediation effect of environmental response efficacy. Framing was coded based on the results above (0 = *loss frame*, 1 = *gain frame*).

Immediate effects. A PROCESS model for the direct effect moderation (model 5; Hayes, 2012) was tested with framing as the independent variable, environmental response efficacy at Time 2 as the mediator, interactivity as the moderator, and environmental behavioral intentions at Time 2 as the dependent variable. Bootstrapping methods were used, and the results of both direct and indirect effects are reported in Table 2.

At Time 2, gain framed experiences led to greater perceptions of environmental response efficacy. Environmental response efficacy, in turn, led to greater intentions to engage in environmental behavior, mediating the relationship. Thus, H3 was confirmed. However, the interaction between framing and interactivity did not have a significant influence on behavioral intentions, and H4 was not supported. However, higher levels of interactivity had a direct effect on environmental behavioral intentions. Thus, although interactivity did not moderate the effect of framed experiences, high interactivity led to greater behavioral intentions than low interactivity after framed experiences.

Table 3. Regression Weights, Indirect Effects Showing Mediation, Bootstrap 95% CI, Lower and Upper Bounds.

			Bootstrap 95% CI	
Regression weights	Coefficient	*SE*	Lower	Upper
Direct effects				
Framing → Response efficacy**	.65	.18	.290	1.000
Response efficacy → Behavior**	.40	.07	.252	.548
Framing → Behavior	.12	.19	.534	−.255
Interactivity → Behavior**	.50	.17	.157	.852
Framing × Interactivity → Behavior	−.38	.25	−.878	.114

			Bootstrap 95% CI	
	Effect size	Bootstrap *SE*	Lower	Upper
Indirect effects				
Framing → Response efficacy → Behavior*	.26	.08	.109	.448

Note. Bootstrap resampling = 1000. CI = confidence interval.
*$p < .05$. **$p < .01$.

Delayed effects. To address RQ2 and RQ3, the same PROCESS model was tested with framing as the independent variable, environmental response efficacy at Time 3 as the mediator, interactivity as the moderator, and self-reported environmental behavior at Time 3 as the dependent variable. Again, bootstrapping methods were used, and the results of both direct and indirect effects at Time 3 are reported in Table 3.

These results indicated that environmental response efficacy mediated the relationship between framing and self-reported environmental behaviors 1 week following the virtual experience. Although the earlier ANOVA revealed no direct effects of framing on self-reported environmental behaviors at Time 3, it is interesting to note that the effect of gain framed experiences on perceived environmental response efficacy persisted over time. However, the interaction between framing and interactivity did not have a significant influence on environmental behavior. Again, interactivity did not moderate the effect of framed experiences, but high interactivity led to greater self-reported environmental behavior than low interactivity 1 week following framed experiences.

Discussion

Summary of Findings

Overall, receiving any form of environmental message via VEs reduced actual paper consumption by approximately 25% compared to baseline levels of paper use. Furthermore, presenting the environmental benefit of paper conservation in the form of a vivid virtual experience of growing a tree helped increase environmental response efficacy, which in turn led to greater intentions to engage in environmental behaviors compared to the loss framed experience of cutting down a virtual tree. One week following the experimental treatment, the heightened level of response efficacy from the gain framed experience persisted; framing did not affect self-reported environmental behavior at Time 3, however. Interactivity within the VE did not moderate the effect of framing. Rather, higher levels of interactivity led to greater environmental behavioral intentions immediately following exposure and greater self-reported environmental behavior for up to 1 week following exposure, and this finding yields important theoretical and practical implications.

Gain and Loss Framed Virtual Experiences

The bulk of earlier framing research has followed stringent definitions of a gain or a loss frame based on the original Kahneman and Tversky (1979) study by manipulating subtle cues in the message while keeping all other aspects of the message equivalent. Limited work on visual framing has demonstrated that stipulations of classical framing theories still apply to both platforms but visual frames are better able to augment health message effects compared to verbal frames (Schneider et al., 2001). Within the context of gain and loss framing, studies have extended earlier work that used videos to manipulate the actual content of framed messages to increase emphasis on the positive and negative consequences (Kim, 2012). Framed virtual experiences, as currently operationalized, further extend the boundaries of classical gain and loss framing research in several ways.

First, with the growing adoption of sophisticated media technologies, framing no longer has to remain confined to verbal and static pictorial messages. VEs yield potential advantages over traditional frames, particularly in the context of gain and loss frames aiming to modify behaviors. One such advantage is that virtual experiences are more persuasive than messages in print or video presenting comparable amounts of information (Ahn et al., in press; 2013), most likely due to VEs' unique affordances such as simulated sensory information and high interactivity. These affordances seemed to result in the persistent salience of virtual experiences in the mind as vivid experiences, implying that classical stipulations of framing theories, although still applicable, become amplified in VEs and the effects are sustained over time. Hence, the current results extend prior findings by demonstrating the effectiveness of nonverbal frames delivered as simulated experiences, the advantage of gain frames over loss frames in the promotion of response efficacy and environmental behavioral intentions, the persistence of gain framed experiences in VEs over time, and the underlying mechanism of response efficacy driving these effects.

Second, these results echo earlier studies on environmental message framing that demonstrated the relative power of gain frames over loss frames (Maibach et al., 2010; Morton et al., 2011; Obermiller, 1995). As mentioned earlier, one potential reason for the knowledge-to-action gap may be the temporal distance between the cause (nonenvironmental behavior) and the effect (environmental damage). Virtual experiences may be used to make this abstract relationship more tangible by allowing individuals to personally experience the future effects. Indeed, several studies have demonstrated the persuasive power of VEs in promoting favorable attitudes and behaviors by vividly depicting the future consequences of present actions (Fox & Bailenson, 2009; Fox et al., 2009; Hershfield et al., 2011). The current experiment is the first attempt to apply this strategy within framing theory in an environmental communication context.

Another advantage of VEs relevant to this argument is the high controllability and malleability of message construction within VEs, meaning that temporal and spatial boundaries in the physical world may be digitally overcome in implementing the frame. In the current study, the future positive benefits or negative consequences of present environmental behaviors were depicted in the simulation. VE simulations that "fast-forward" time so that individuals are able to vividly experience future events in the present, mediated world may help overcome individuals' limitations in processing information presented in traditional framed messages, which rely on an individual's ability to understand the content and imagine the connection between individual actions and environmental consequences. Individuals who have trouble constructing mental imagery (Hall & Martin, 1997) or have low numerical ability and cannot make sense of statistical or probabilistic projections made about environmental destruction (Hart, 2013) may especially benefit from virtual experiences.

Perhaps more importantly, the current experiment demonstrated that environmental response efficacy was the underlying mechanism driving environmental behavior both immediately and 1 week after exposure to framed experiences. This finding echoes earlier studies that have confirmed efficacy as a predictor of environmental behaviors (Cleveland et al., 2005; Hines et al., 1987; Smith-Sebasto & Fortner, 1994). Furthermore, an earlier VE study demonstrated that the vivid sensory experience during a virtual experience encourages children to encode the digital simulation as a personal experience (Segovia & Bailenson, 2009). Personal experiences have been shown to be more impactful in decision-making than reading a description of the experience even when the information given is equivalent (Hertwing et al., 2004; Marx et al., 2007). Also, experiences of prior success are thought to be one of the strongest drivers of efficacy (Bandura, 1997). Taken together with the results of the current experiment, the vivid virtual simulation of successfully growing a tree to maturity may have been encoded as a personal experience and affected an individual's confidence that he or she can improve the environment, whereas the detrimental behavior of cutting down a tree did not promote this belief.

Contributions to VE Research

Overall, any form of exposure to environmental messages in a VE led to a significant reduction in paper consumption compared to not receiving any VE treatment. This suggests that the effects of virtual experiences are strong enough to transfer into the physical world to modify behavior. Thus, there is much potential to use virtual experiences to boost an individual's confidence in engaging in a particular behavior to promote in the physical world. Previous studies have demonstrated that simulated experiences within VEs lead to behavioral changes in the physical world in terms of exercising (Fox & Bailenson, 2009), helping (Ahn et al., 2013), and negotiation tasks (Yee, Bailenson, & Ducheneaut, 2009), but this is one of the first attempts at promoting environmental behaviors using VEs (cf. Ahn et al., in press).

Results also suggested that interactivity may be a key element in forming a virtual experience persuasive enough to carry over into the physical world. Although interactivity did not serve as a moderator as hypothesized, we found that higher levels of interactivity led to greater behavioral intentions immediately following exposure to the VE and greater self-reported environmental behavior 1 week afterward. Although it was not directly measured in the current study, it may be that interactive elements that allowed individuals to actively engage in the virtual experiences led to greater involvement with the message (Petty & Cacioppo, 1986), leading to persisting changes in environmental behaviors. Another possible explanation is that higher interactivity led to a more believable experience compared to merely watching events occurring on the screen (Fortin & Dholakia, 2005), leading to greater persuasion to change behaviors in the physical world. Involvement, perceived realism, and other relevant variables should be explored in future work.

Considering that the brief exposure to interactive experiences led to effects persisting for up to 1 week, VEs may serve as more powerful channels for persuasive messages encouraging behavioral modifications in the physical world compared to less interactive media. Earlier studies have demonstrated that more interactive experiences amplify intended effects compared to less interactive experiences (Skalski, Tamborini, Shelton, Buncher, & Lindmark, 2011). The current results expanded these earlier findings by involving interactive elements in a virtual experience to modify a targeted behavior. Further research may investigate different forms of interactivity within persuasive messages.

Limitations and Future Directions

Although gain framed experiences elicited higher response efficacy than loss framed experiences that persisted for up to 1 week, self-reported environmental behavior did not differ significantly between the framing conditions 1 week following exposure to the virtual experiences. One possible explanation for the lack of behavior change is that the virtual experience did not provide a specific plan of environmental action for participants. Although the framed experiences within the VE in the current study may have depicted future consequences of compliance and non-compliance more lucidly compared to traditional framed messages, it may not have been clear to participants what specific behaviors to engage in to avoid the loss or achieve the gain. In future studies, the virtual experience should also incorporate an opportunity for the individual to engage in specific environmental behaviors such as recycling that the environmental message is trying to promote.

Another lingering question is the underlying mechanism driving the behavioral change observed through the napkin measure. An earlier study (Ahn et al., in press) demonstrated that cutting a virtual tree promotes less napkin use compared to reading a description, and the current results extend these findings by showing that both gain and loss framed VE experiences yield less napkin use compared to a no-treatment control. Thus, it is clear that VE experiences promote immediate behavioral changes, but the underlying mechanism driving these changes remains unclear. In the current experiment, the control condition only served as a baseline for napkin use, and the lack of other measures from the control condition made it difficult to explore underlying mechanisms. Future studies should focus on investigating whether environmental attitudes, such as response efficacy, drive the immediate change in environmental behaviors.

In addition, scholars have begun to explore the effects of different types of frames competing against each other when they are presented simultaneously (Borah, 2011). With the seemingly limitless accessibility to information today, it is highly unlikely for individuals to receive only one type of frame for a single issue. Rather, outside the controlled environment of the laboratory, they are likely to be exposed to messages of multiple frames at once. Future research should explore the effects on environmental response efficacy and behavior when individuals are exposed to both gain and loss framed virtual experiences at once.

One variable that has been investigated in persuasive health contexts is perceived risk. Given that there is some variation in the belief about whether or not certain environmental problems do, indeed, exist (Hart & Nisbet, 2012), it may be that perceived risk plays an important role in the relative success of gain versus loss framed experiences in this context.

Although interactivity directly influenced environmental behavioral intentions and self-reported behavior, it did not moderate the gain and loss framed experiences. One possibility is that although undergoing a highly interactive experience in VE elicits more environmental behavior compared to virtual experience with low interactivity, it is not a relevant moderating variable for framed experiences. Both the gain and loss framed messages have a single common goal of paper conservation and the results seem to suggest that interactivity triggers individuals to meet that goal regardless of framing. Thus, the implication seems to be that rather than framing effects being contingent upon different levels of interactivity, the two variables are independent of each other.

The use of a student sample is a noted limitation in this study. College students spend considerable amounts of time with digital media (Pew Research Center, 2010), which may make the effects of VEs different for this demographic. College students may also be more sensitized to environmental issues than other groups. Future studies should investigate the effects of framed virtual experiences across a wider range of populations and with a larger sample for greater generalizability of results.

Conclusion

With the advent of affordable and accessible advanced digital media technology, VEs are rapidly becoming an everyday platform for the masses (Blascovich & Bailenson, 2011). Furthermore, natural mapping input devices, much like the haptic device used for this experiment, are a novel but an increasingly popular control mechanism for modern video game consoles (e.g., Microsoft Kinect, Nintendo Wii). As a wide range of scalability is one of the advantages of digitized messages, these experiences may be easily embedded into any form of interactive media content and experienced by individuals in either educational settings or within the comfort of their homes. Considering that our preliminary results suggest that even a brief framed experience in VEs can be powerful enough to persist and change actual behavior in the physical world, the outlook of such an application is encouraging.

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