

Effects of 3D Virtual Haptics Force Feedback on Brand Personality Perception: The Mediating Role of Physical Presence in Advergames

Seung-A Annie Jin, Ph.D.

Abstract

This study gauged the effects of force feedback in the Novint Falcon haptics system on the sensory and cognitive dimensions of a virtual test-driving experience. First, in order to explore the effects of tactile stimuli with force feedback on users' sensory experience, feelings of physical presence (the extent to which virtual physical objects are experienced as actual physical objects) were measured after participants used the haptics interface. Second, to evaluate the effects of force feedback on the cognitive dimension of consumers' virtual experience, this study investigated brand personality perception. The experiment utilized the Novint Falcon haptics controller to induce immersive virtual test-driving through tactile stimuli. The author designed a two-group (haptics stimuli with force feedback versus no force feedback) comparison experiment ($N = 238$) by manipulating the level of force feedback. Users in the force feedback condition were exposed to tactile stimuli involving various force feedback effects (e.g., terrain effects, acceleration, and lateral forces) while test-driving a rally car. In contrast, users in the control condition test-drove the rally car using the Novint Falcon but were not given any force feedback. Results of ANOVAs indicated that (a) users exposed to force feedback felt stronger physical presence than those in the no force feedback condition, and (b) users exposed to haptics stimuli with force feedback perceived the brand personality of the car to be more rugged than those in the control condition. Managerial implications of the study for product trial in the business world are discussed.

Introduction

WHAT ARE THE EFFECTS of the sense of touch and 3D virtual haptics in interactive media environments? The current experimental study examined the effects of haptics force feedback (vs. no force feedback) on the *sensory* (physical presence) and *cognitive* (brand personality perception) outcomes of a virtual experience.

Haptics is defined as "the modality of touch and associated sensory feedback."^{1(p1)} Machine haptics refers to the use of robotic and other devices to simulate the sense of touch in computer-generated virtual reality or augmented reality environments.^{1,2} This study examined the sense of 3D virtual touch in the novel context of virtual simulation driving using an innovative interactive haptic system, *Novint Falcon*. Novint Falcon is a 3D, 3-degrees-of-freedom (DOF) haptics technology that enables users to experience realistic senses of touch such as texture, vibration, depth, friction, and weight.³

Effects of force feedback haptics stimuli on physical presence

Physical presence refers to "a psychological state in which virtual physical objects are experienced as actual physical objects."^{4(p44)} Physical presence occurs when technology users do not notice either the para-authentic or artificial nature of mediated objects, environments, or simulated objects.⁴ Novint Falcon haptics interface's realistic and immersive driving experience through 3D virtual touch and handling physics can induce strong feelings of physical presence. Tactile stimuli with force feedback, such as feeling the road condition, bumps on the road, and objects in the driving environment, can enable users to feel physical presence. In the present study, therefore, it was hypothesized that force feedback in haptics would increase physical presence:

H1: People who are exposed to haptics stimuli with force feedback will feel stronger physical presence than those exposed to haptics stimuli without force feedback.

Effects of force feedback haptics stimuli on brand personality perception

Brand personality is defined as “the set of human characteristics associated with a brand.”^{5(p347)} Consumer behavior research shows that consumers often imbue brands with human personality traits.⁵ In fact, the idea that brands have personalities or human characteristics is well established in literature.^{6,7} There are five dimensions of brand personality: sincerity, excitement, competence, sophistication, and ruggedness.⁵ The sincerity dimension of brand personality can be typified by Hallmark cards.⁵ Competent brands like the *Wall Street Journal* symbolize reliable, responsible, and dependable brand personalities.⁵ Exciting brands can be characterized by daring, spirited, imaginative, and up-to-date images, like that of the MTV channel.⁵ Rugged brands like Harley-Davidson and Marlboro embody masculinity, defiance, and rugged individualism.⁷ Sophisticated brands such as Mercedes and Chanel, on the other hand, are associated with upper-class, glamorous, and feminine images.⁵ In the present study, a rally car was used in the dirt-roads driving environment. Based on this rationale (i.e., the nature of the experimental setting, which mainly evokes consumers’ perception of a rugged brand personality), the ruggedness dimension of brand personality was examined. Expanding the scope of brand personality research beyond the traditional marketing domain, Park et al.⁸ examined the influence of *visual* attributes on brand personality perception in electronic commerce (e-commerce) and human-computer interaction (HCI). The present study took the next step and explored the effects of the *tactile* properties of consumer-product interaction in 3D virtual environments on consumers’ brand personality perception.

H2: People who are exposed to haptics stimuli with force feedback will perceive the car’s brand personality to be more rugged than those exposed to haptics stimuli without force feedback.

Mediating effects of physical presence

A considerable amount of research has shown that feelings of presence play a significant mediating role in computer-mediated communication (CMC), human-computer interaction (HCI), and human-robot interaction (HRI).⁹ Different types of presence (e.g., social presence, self-presence, and physical presence) play a distinct role in diverse media environments. In multiuser media environments, social presence (feelings of coexisting with other actors) plays a mediating role.¹⁰ Self-presence (the extent to which the virtual self, such as an avatar, is experienced as the actual self) occurs in avatar-based, single-user media environments.¹¹ Physical presence plays a mediating role in augmented reality and 3D virtual reality. For example, Klein¹² found a significant mediating effect of physical presence in people’s virtual experiences in new media. Among different types of feelings of presence, the current experiment focused on physical presence based on the rationale that the experiment was conducted in *non-avatar-based, single-player, immersive 3D virtual reality haptic interfaces* (i.e., Novint Falcon). The third hypothesis proposed the mediating effect of physical presence in the 3D virtual haptics interface.

H3: The effects of haptics stimuli with force feedback on brand personality perception will be mediated through feelings of physical presence.

Method

Apparatus

The experiment utilized the Novint Falcon haptics controller. Novint Falcon is a robotic joystick that provides high-fidelity touching of virtual objects, characters, and environments.³ Software used for the experiment was XLR8, a virtual simulation driving program.¹³ Figure 1 depicts the experimental setup.

Sample

Participants were 238 undergraduate students (78 males; 160 females) recruited from a university in the United States.

Design and manipulation

The experiment employed a two-group (haptics stimuli with force feedback vs. haptics stimuli without force feedback) comparison design. Participants were asked to experience a virtual test-drive using the Novint Falcon haptics machine. Participants were randomly assigned to one of the two conditions. Participants in the haptics stimuli with force feedback condition test-drove the car using the Novint Falcon device, which was set up to produce force feedback. In order to maximize the effects of force feedback manipulation, terrain effects, acceleration, and lateral forces were set at the maximum level. In contrast, participants in the haptics stimuli without force feedback condition test-drove the car using the Novint Falcon device but were not given any force feedback stimuli. Figure 2 shows detailed information regarding



FIG. 1. Experimental setup: Novint Falcon 3D virtual haptics.

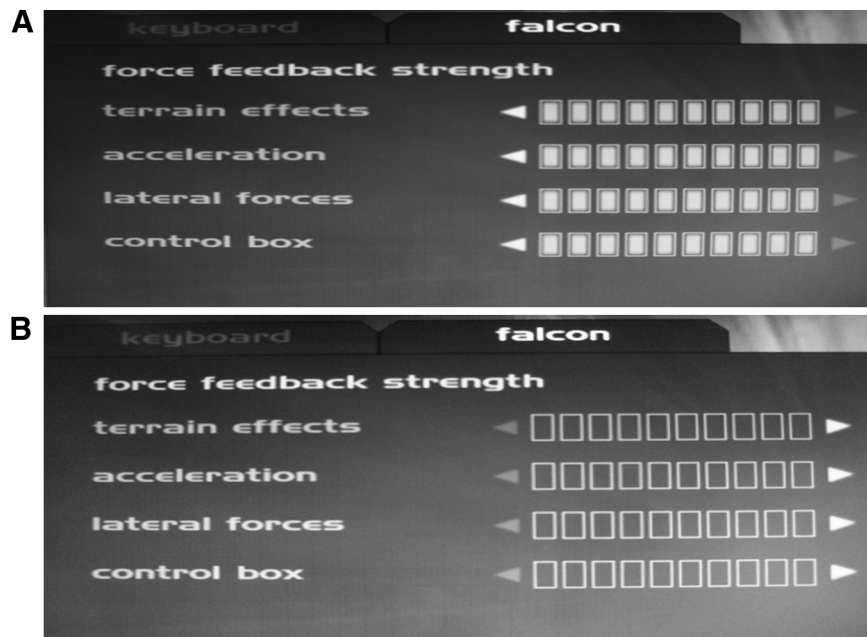


FIG. 2. Force feedback manipulation (A) versus no force feedback manipulation (B).

the properties of force feedback manipulation with maximum terrain effects, acceleration, and lateral forces (top) versus no force feedback manipulation without such effects (bottom).

Measures

*Rugged brand personality*⁵ was measured using a 7-point Likert scale ranging from 1, *Not at all describes*, to 7, *Perfectly describes*. Participants were asked to indicate how well the items described the brand personality of the car they test-drove. The five items were: outdoorsy, masculine, Western, tough, and rugged (Cronbach's $\alpha = 0.82$).

Physical presence was measured using a 7-point Likert scale ranging from 1, *Not at all*, to 7, *Very much*. The five items were: (1) While you were test-driving the car, how much did you feel as if the objects on the road were real? (2) While you were test-driving the car, how much did you feel that you could feel the surface of the road? (3) While you were test-driving the car, how much did you feel that you could feel the road condition? (4) While you were test-driving the car, how much did you feel that the objects on the road seemed to be heading toward you? (5) While you were test-driving the car, how much did you feel as if you were the real driver? (Cronbach's $\alpha = 0.88$).

Result

Effects of force feedback haptics stimuli on physical presence

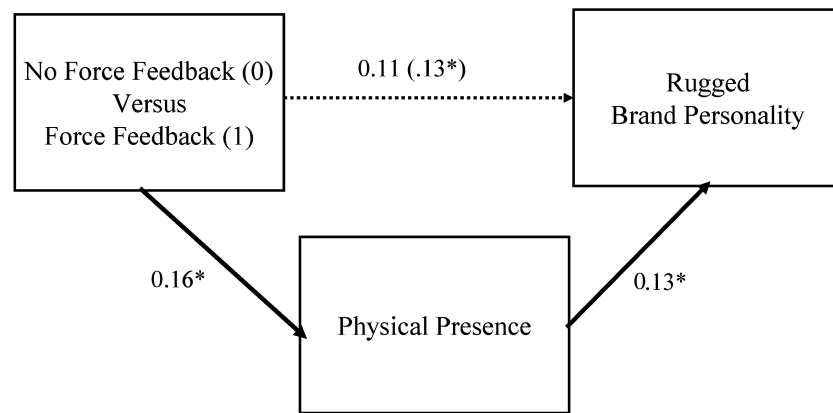
A one-way ANOVA indicated significant effects of haptics force feedback on physical presence, $F(1, 237) = 6.05, p < 0.05$, partial $\eta^2 = 0.03$. Users who were exposed to haptics stimuli with force feedback felt stronger physical presence ($M = 3.80, SD = 1.32$) than those who were exposed to haptics stimuli without force feedback ($M = 3.37, SD = 1.41$). H1 was supported.

Effects of force feedback haptics stimuli on rugged brand personality perception

A one-way ANOVA indicated significant effects of haptics force feedback on rugged brand personality perception, $F(1, 237) = 4.06, p < 0.05$, partial $\eta^2 = 0.02$. Users who were exposed to haptics stimuli with force feedback perceived the car's brand personality to be more rugged ($M = 3.69, SD = 1.38$) than those who were exposed to haptics stimuli without force feedback ($M = 3.34, SD = 1.26$). H2 was supported.

The mediating role of physical presence

A path analysis was conducted to test if physical presence mediates the effects of haptics force feedback on rugged brand personality perception (H3). Five criteria need to be met to prove the mediation process.¹⁴ The first criterion is that the independent variable, the type of haptics stimuli (dummy coded: 0 for haptics stimuli without force feedback and 1 for haptics stimuli with force feedback), should have a significant effect on the mediator, physical presence ($\beta = 0.16, p < 0.05$). The second criterion is the significant effect of the mediating variable (physical presence) on the dependent variable (rugged brand personality perception) ($\beta = 0.15, p < 0.05$). The third criterion is that when the dependent variable is regressed on the independent factor without the mediator, the independent variable should significantly predict the dependent variable ($\beta = 0.13, p < 0.05$). Fourth, when both the independent variable and the mediator are used as predictors for a regression equation, the effect of the mediator on the dependent variables should still remain statistically significant ($\beta = 0.13, p < 0.05$). Fifth, when the dependent variable is regressed both on the independent and mediating variables, the effect of the independent variable (haptics stimuli with force feedback vs. without force feedback) on the dependent variable (rugged brand personality perception) should



* $p < .05$

Note 1. The number inside the parentheses is standardized coefficient when the dependent variable is regressed on the independent variable alone without including the mediating variable (physical presence) in the equations.

Note 2. The independent variable was dummy coded (0: No Force Feedback vs. 1: Force Feedback).

FIG. 3. Path diagram of mediation analysis (H3): Mediating effects of physical presence.

decline and become nonsignificant ($\beta = 0.11$, $p = ns$). Figure 3 shows that physical presence plays a mediating role in consumers' brand personality perception. H3 was supported.

Discussion

First, the present study examined the effects of force feedback in tactile stimuli on haptics interface users' feelings of physical presence. Results showed that the inclusion of force feedback (as opposed to the absence of force feedback) increased physical presence. Second, this study evaluated the impact of force feedback on consumers' brand personality perception, thus providing empirical evidence in support of the effects of tactile input on cognitive information processing. This result has important managerial implications. Haptic information can be incorporated innovatively into product design as well as marketing messages to influence consumers' perception of brands and products. Findings from the current experiment strongly support the efficacy of integrating haptic components into trial products to influence consumer's brand personality perception more effectively. Additionally, much research has emphasized the importance of "brand personality," suggesting that it can provide a point of differentiation,^{5,15} create emotional benefits,¹⁶ and serve as a basis for consumer-brand relationship building.¹⁷ Thus, marketing practitioners view brand personality as a key way to differentiate a brand in a product category,¹⁸ a central driver of consumer preference and usage,¹⁹ and a common denominator deployed to market a brand across cultures.¹⁵ Adding haptic modality to 3D virtual objects and environments can contribute to the vivid and realistic presentation of products by inducing strong feelings of physical presence as well as evoking consumers' perception of unique brand personality. Finally, the study added empirical evidence regarding the mediating role of physical presence in haptics interfaces.

Limitations of this study need to be addressed because they provide interesting avenues for future research. First, the current study assumed a simple linear relationship between

the level of force feedback and the outcome variables. However, we can consider a nonlinear (e.g., curvilinear) relationship between the amount of force feedback and people's reaction to it. For example, finding the optimal level of force feedback (instead of the maximum level) would provide helpful insights into haptics interface design. Second, only the quantity dimension of force feedback was manipulated in the study. Manipulation of the quality of tactile information (e.g., pleasant touch vs. unpleasant touch; diagnostic touch vs. nondiagnostic touch; utilitarian touch vs. hedonic touch) or measurement of users' perceived quality of the touch would advance our understanding of media users' tactile information processing in a machine haptics interface. Third, the sample was composed of twice as many female ($N_{\text{Female}} = 160$) as male ($N_{\text{Male}} = 78$) participants, which resulted in an unbalanced gender issue. Given that participants drove a car in the experiment, gender difference with regard to automobile involvement or driving behaviors might have played a role in the virtual test-driving experience. Finally, this study did not address various human factors that may play a moderating role in haptics interfaces. Investigation of individual difference factors, such as a need for touch ("a preference for the extraction and utilization of information obtained through the haptic system"^{20(p431)}), sensation-seeking tendency ("a trait defined by the seeking of varied, novel, complex, and intense sensations and experiences"²¹), or exploratory information-seeking tendency, would further enrich our knowledge about the interaction between haptic stimuli (external media factors) and media users' personality variables (human factors).

Author Disclosure Statement

No competing financial interests exist.

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Address correspondence to:
 Dr. Seung-A Annie Jin
 140 Commonwealth Ave
 21 Campanella Way, 543
 Chestnut Hill, MA 02467
 E-mail: seunga.jin.1@bc.edu

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