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RESEARCH ARTICLE

THE EFFECTS OF PRESENTATION FORMATS AND TASK COMPLEXITY ON ONLINE CONSUMERS' PRODUCT UNDERSTANDING[1]

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Abstract

This study assesses and compares four product presentation formats currently used online: static pictures, videos without narration, videos with narration, and virtual product experience (VPE), where consumers are able to virtually feel, touch, and try products. The effects of the four presentation formats on consumers' product understanding as well as the moderating role of the complexity of product understanding tasks were examined in a laboratory experiment.

Two constructs used to measure product understanding performance are actual product knowledge and perceived website diagnosticity (i.e., the extent to which consumers believe a website is helpful for them to understand products). The experimental results show that (1) both videos and VPE lead to higher perceived website diagnosticity than static pictures; (2) under a moderate task complexity condition, VPE and videos lead to the same level of actual product knowledge, but all are more effective than static pictures; (3) under a high task complexity condition, all four presentation formats are equally effective in terms of actual product knowledge. Moreover, the results also indicate that it is perceived website diagnosticity, not actual product knowledge, that affects the perceived usefulness of websites, which further influences consumers' intentions to revisit the websites.

Keywords: Product presentation, task complexity, virtual product experience, product understanding

Introduction

This study investigates the effects of several online product presentation formats on consumers' actual and perceived product understanding and further assesses the moderating role of task complexity on the effectiveness of these presentation formats.

Both businesses operating online and the consumers who visit their sites have been concerned about how product information is displayed on e-commerce websites and processed by customers (Burke 2002). For example, Jarvenpaa and

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Todd (1996-1997) have found that perception of products is one of the most salient factors influencing consumers' attitudes toward and intentions regarding online shopping. Szymanski and Hise (2000) also observed that the presentation of product information significantly affects consumers' satisfaction with electronic shopping. Consequently, both researchers and practitioners have devoted efforts to improving online product presentations.

Most e-commerce websites currently employ text and pictures to present product information (Lightner and Eastman 2002). Text is normally used to describe *search attributes* (Nelson 1974), such as product size, weight, and warranty policies; while pictures are used to depict the visual appeal of products, which is usually difficult to describe by verbal cues alone (Baggett 1989). However, it has become increasingly evident that text and static pictures are insufficient to present rich product information, particularly for *experience attributes* (Nelson 1974), such as the feel, try, and touch of a product. For example, it is difficult to use only text and pictures to clearly and concretely demonstrate how a product, such as a digital camera, behaves in its different functional modes or how it feels when used.

Research has shown that the insufficient presentation richness of online product demonstrations is a major impediment to e-commerce (Rose et al. 1999). Peterson et al. (1997) have argued that "Internet-based marketing would seem to be a poor substitute for traditional transaction channels, where the goods are available for inspection" (p. 335). Likewise, Burke (2002) and Alba et al. (1997) have indicated that the quality of product information on the Internet has been mediocre, particularly for consumers who are usually accustomed to evaluating product quality based on physical interaction with products. Therefore, the inherent limitation of the Internet interface to present detailed product information likely leads to customers being less knowledgeable about the products that are of interest to them and less informed in making their purchase decisions.

To alleviate this concern, many online firms have experimented with various IT-based tools to enrich product presentations. Among them is the use of video clips to depict featured online products dynamically and continuously (Coyle and Thorson 2001; Raney et al. 2003). For instance, Mercedes-Benz's website (www.mbusa.com) provides video demonstrations that display cars in motion. In addition to visual effects, these video clips are typically integrated with audio cues associated with product performance. Using the Mercedes-Benz example, online customers can also hear the sound of driving while watching the videos so that they can "experience" the cars more and "feel" their speed. Human narration can also be employed to augment video demonstrations by explaining product features to customers. For example, on the website www.mattracks.com, which sells tank-like tracks for consumers who want to convert the tires on their 4 × 4 vehicles, consumers can view video clips of tracks used in different road conditions while listening to a narration explaining why these tracks provide sufficient traction and mobility.

In an attempt to further enhance and optimize customers experiences with products, recent Internet-based virtual reality (VR) technologies have made it possible for customers to feel, touch, and try products on commercial websites (Jiang and Benbasat 2005; Li et al. 2001; 2002; 2003; Suh and Lee 2005). Using their computer mouse and keyboard, customers visiting Olympus website (www.olympus.com), for example, can rotate cameras three dimensionally and view the cameras from different angles; they can place themselves inside cars and obtain panoramic views of their interior settings on Honda website (www.honda.com); and they can operate different functions of sports watches by pressing functional buttons on Timex website (www.timex.com). All of these online experiences can be categorized as *virtual product experiences* (VPE), defined as web shopping experiences that allow consumers to interact with and try products via web interfaces.

The present paper empirically compares and evaluates the effects of the aforementioned four types of online product presentations—using static pictures, using videos without narration, using videos with narration, and using VPE—on consumers product understanding (Hoch and Deighton 1989). Two indicators of product understanding performance are investigated: consumers actual product knowledge and perceived website diagnosticity (i.e., consumers perceptions of how a website is helpful for them to understand products). The concurrent test of consumers actual and perceived product understanding is necessary, because there is evidence that an intriguing and compelling product experience may sometimes cast an unrealistic illusion on consumers perceptions of its effectiveness, but actually fail to improve consumers actual product learning performance (Hoch 2002). Moreover, both perceived website diagnosticity and actual product knowledge are embedded within a nomological network to assess their relative effects on the perceived usefulness of websites (shown to be the best predictor of intended website usage; see Koufaris 2002).

Another purpose of the present paper is to investigate the moderating effects of task complexity on the effectiveness of online product presentation formats. This objective is motivated by the observation that current online product presen-

tations display products with different level of complexity, ranging from those with relatively few or moderate amounts of product attributes, for example, the presentations of an office table (www.officedepot.com) or a watch (www.timex.com) to those with highly complex features, such as the demonstrations of a digital camera (www.kodak.com) or a laptop computer (www.apple.com). There seems to be a presumption that the more multimedia features employed, the more attractive and informative a product presentation. However, it has not yet been empirically examined whether or not the complexity of product evaluation tasks influences the effectiveness of various product presentation formats, although previous research on task/technology fit implies there is such a possibility (Speier 2003; Zigurs and Buckland 1998).

Overall, this study aims to make three contributions. First, it compares four types of online product presentations, including two video conditions (i.e., video-without-narration and video-with-narration) that have been overlooked in prior studies. Second, it investigates the different effects of product presentations on both actual product knowledge and perceived website diagnosticity, as well as the different effects of these two facets of product understanding on related consumer behavior. Third, the study reveals the moderating effects of task complexity on product understanding, an issue that has not been tested in any previous empirical study.

Review of Theoretical Foundations

Online product presentations are designed to introduce products to consumers, to help consumers to form a clear *understanding* of products, and, ideally, to impress consumers with superior or attractive product features (Hoch and Deighton 1989). As mentioned above, current online product presentations are typically pictorial or image-based, in an attempt to use vivid visual effects to facilitate consumers' understanding of how a product performs, encompassing the product's appearance, functionality, and its behavior under different working conditions. Vessey and Galletta (1991) suggest that different types of presentation formats significantly influence the quality of cognitive learning. Hence, within the context of online product demonstrations, the key question is: What is the most appropriate type of pictorial presentations to help consumers with product understanding? Two relevant streams of research are accordingly discussed below: multimedia learning and active learning.

Multimedia Learning

A multimedia environment encompasses information that are presented in more than one sensorimotor channel, such as the auditory channel, including human speech and environmental sounds, and the visual channel, including static images and dynamic animation or video (Mayer 2003; Mayer et al. 1999). Substantial prior research has shown that appropriate use of multiple sensory cues in multimedia can effectively represent nonverbal information, enhance learning performance and experience, and help form mental representations of objects (Carney and Levin 2002; Mayer et al. 2003; Mayer and Gallini 1990; Moreno and Mayer 2002).

Cue-Summation Theory and Dual Coding Theory

The efficacy of learning in a multimedia environment can be explained and predicted by two fundamental theories in communication: the *cue-summation* theory and the *dual coding* theory. The cue-summation theory posits that learning is more effective as the number of available cues or stimuli (either across channels or within channels) increases (Moore et al. 1996; Severin 1967). Severin (1967) has further noted that cues must be relevant in order to enhance learning. He has asserted that "multiple-channel communications appear to be superior to single-channel communications when relevant cues are summated across channels" (p. 397), and that "when irrelevant cues are combined" (p. 397), the learning effect will be inferior.

The dual coding theory is about the nature of symbolic and sensorimotor systems. Specifically, sensorimotor systems include visual, auditory, haptic, taste, and smell channels; while symbolic systems are related to how perceived information is processed and involves verbal and nonverbal systems. The dual coding theory (Paivio 1986; 1991) assumes an orthogonal relationship between symbolic systems and specific sensorimotor systems. For example, some information collected via the visual channel (e.g., visual words) is represented in the verbal system, while other information (e.g., visual objects) is represented in the nonverbal system. Similarly, some information from the auditory channel (e.g., environmental sounds) produce a mental representation in the nonverbal system, while other information (e.g., auditory words) is mapped to the verbal system.

An important assertion of the dual-coding theory is that verbal and nonverbal systems function independently and can have additive effects on human memory and understanding (Paivio 1991). Therefore, the effects of multimedia learning are largely due to the fact that multimedia can utilize multiple sensory channels to convey information to users, which builds respective mental representations in both verbal and nonverbal systems. These two types of representations corresponding to the same object strengthen each other, and consequently facilitate understanding.

Working Memory and Split-Attention Effect

Another theoretical foundation for multimedia learning is on working memory and split attention effect. Research on working memory assumes that people only have limited working memory to process incoming information; therefore, if one's working memory is overloaded, the learning effect will deteriorate (Baddeley 1992). Research has also found that working memory has a modality effect (Penney 1989), that is, the effective size of working memory can be increased by presenting information in a mixed channel (e.g., visual and auditory) compared to in a single channel (e.g., visual only).

Applying the theories on working memory to multimedia learning, Mayer and Moreno (1998) have proposed a split-attention effect. They argue that the visual channel is typically associated with a heavy cognitive load, such as on-screen text and pictorial information, and therefore people have to split their attention among these visual cues. In this context, learning is improved if on-screen text is presented as verbal narration, so that it can be processed through the verbal channel, thus freeing the capacity of visual channel to process pictorial information more extensively.

Active Learning

Several recent studies in the multimedia and education literatures have argued that multimedia should provoke active learning in order to improve learners' performance and their learning experiences (Carroll et al. 1985; Schank 1994). For example, Mayer (2003) has suggested that meaningful learning occurs when learners engage in actively processing information presented to them, and when they actively construct mental representations. In another study, Mayer et al. (1999) have termed this process *constructivist learning*. Both studies argue that active learning includes paying attention to the process of selecting relevant information from words and pictures, mentally organizing the words and pictures into coherent verbal and pictorial representations (*internal connections*), and integrating the representations with one another and with relevant prior knowledge (*external connections* or *referential connections*).

Carroll et al. (1985) have suggested that active learning typically takes the form of learning by doing, by thinking, and by knowing. Specifically, in an active learning mode, learners prefer to try things out rather than reading or following structured step-by-step formulae. They prefer to make sense of their learning experiences by developing and examining hypotheses rather than by depending on rote assimilation of information. They also tend to relate their learning experiences to prior knowledge or metaphors (Carroll and Mack 1999) to figure out how to perform certain processes and to decide which processes to perform.

In summary, based on the theories of multimedia learning and active learning, online product presentations should include multiple sensory cues and channels and involve more extensive active interactions with consumers, to facilitate consumers' product understanding.

Hypotheses Development

Independent and Dependent Variables

In this study we examine the effectiveness of four types of online product presentation formats that are applied widely in current e-commerce websites: the *static-picture* format, the *video-without-narration* format, the *video-with-narration* format, and the *virtual-product-experience* (VPE) format and investigate the moderating role of task complexity.

The static-picture format presents product information on a website through static images combined with relevant explanatory text or hypertext descriptions. The two video formats present product information on a website by continuous video demonstrations, including dynamic visual stimuli such as the change of product images and corresponding product sound effects, such as a watch's alarm. These two formats differ in that the video-without-narration condition uses text descriptions to explain product features, while in the video-with-narration condition detailed text explanations are narrated aloud in connection with the video. The VPE format presents product information by allowing consumers to interact with a product simulator and sample product features as they can do in a direct product experience.

Two major dependent variables have been used to measure consumers' product understanding performance from two perspectives: actual and perceived. The first, labeled *actual product knowledge*, refers to the extent to which consumers actually understand product information. The second dependent variable, labeled *perceived website diagnosticity*, is defined as consumers' perceptions of the extent to which a particular website is helpful for them to understand products in online shopping (Jiang and Benbasat 2005; Kempf and Smith 1998). The choice of these two dependent variables is due to the concern that users' self reporting of their performance of using information systems is sometimes a poor surrogate for their objective performance (Goodhue et al. 2000). Furthermore, perceptions are key influences on intended be-

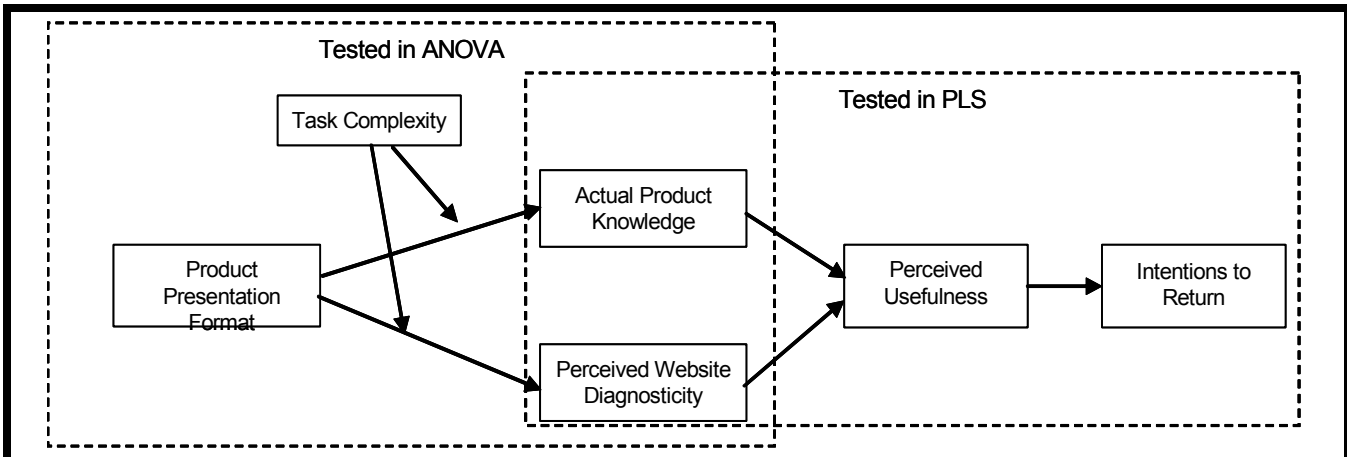

Figure 1. Research Model

haviors. Given that an important goal of product presentations on websites is to promote products and encourage consumers' patronage, it is important to assess the effects of the four presentation formats on perceptual constructs that can potentially influence consumers' intentions to revisit the websites.

The entire research model is shown in Figure 1.

Hypotheses Development

Video Versus Static Pictures

The essential characteristic that distinguishes video from static pictures is its ability to depict temporal visual change. Based on the cue-summation theory, video demonstrations likely benefit users' learning more than static pictures, when all these presentation cues are relevant to product performance. The temporal visual changes and associated sound effects of videos can build associative interconnections with each other and thus produce a more thorough nonverbal symbolic representation of product performance than static images. For example, Park and Hopkins (1993) have suggested that a dynamic depiction can make change processes more explicit and easier to understand than static pictures. When dynamic processes are presented by static pictures, learners are forced to construct a mental representation that can integrate a range of static information based on symbolic representations and text descriptions. In contrast, video is superior to static pictures, inasmuch as it provides a ready-made format so learners can directly use it to understand the internal mechanisms of products. Consequently, Park and Hopkins have argued that video can facilitate deeper understanding than static pictures do. Therefore, we propose

H1a: Product presentations in video formats (both video-without-narration and video-with-narration) lead to higher actual product knowledge in consumers than those in a static-picture format.

On the other hand, consumers' perception of a website's capability to help them learn product information is likely determined by their perception of the richness of the web interfaces because richer media are typically considered more capable of unambiguously conveying information (Daft and Lengel 1979; Daft et al. 1987). Since video employs dynamic visual changes and associated sound effects, presentations in video formats are perceived as richer than those in a static-picture format. Therefore, we propose

H1b: Product presentations in video formats (both video-without-narration and video-with-narration) lead to higher perceived website diagnosticity than those in a static-picture format.

Video-with-Narration Versus Video-Without-Narration

Prior research on working memory and split-attention effects has suggested that splitting attention between multiple sources of information on a single sensory channel can cause cognitive overload and hence a large reduction in people's memory

and learning, especially at the information encoding stage (Craik et al. 1996; Mousavi et al. 1995). Research has also indicated that presenting information using mixed sensory channels can ameliorate this split-attention effect, and thus improve learning performance over using a unitary channel. Based on these findings, Mayer and Moreno (1998, 2002) have contended that video-with-narration is more effective in provoking user memory and learning than video-without-narration. This is because narration conveys explanatory product information by employing audio channels, which operate independently from visual channels, hence enabling users to engage more of their working memory to process other pictorial information in vision, and thereby facilitating deeper understanding of products. This is unlike a video-without-narration condition, where explanatory text information competes for consumers' limited visual processing resources and thereby causes an unfavorable split-attention effect when consumers are simultaneously engaged in examining pictorial product demonstrations. Therefore, we propose

H2a: Product presentations in a video-with-narration format lead to higher actual product knowledge in consumers than those in a video-without-narration format.

Similarly, consumers may also perceive that the use of narration instead of on-screen text can enhance learning effectiveness for two reasons. First, since narration allows them more working memory to process information and understand products, consumers may feel that narration makes their learning tasks easier and facilitates their product understanding. Second, since human narration involves inflection, pitch, tone, and pauses, which can better express equivocal meaning than text (Daft and Lengel 1979; Daft et al. 1987), it is considered as richer than on-screen text; consequently, the video-with-narration condition will be perceived as more helpful to convey information than the video-without-narration condition.

H2b: Product presentations in a video-with-narration format lead to higher perceived website diagnosticity than those in a video-without-narration format.

Virtual Product Experience (VPE) Versus Video and Static Pictures

According to Carroll and Mack (1984), the performance of learners is effectively improved by active learning. This is because in an active learning state, learners generally pay more attention to learning materials and are curious about the exploration experience. They carefully select relevant information, and learn by doing, by thinking, and by relating new information to their prior knowledge, thereby forcing themselves to rehearse and construct mental representations. Hoch and Deighton (1989) divide product experience into two types: passive observation and active, self-directed search. They argue that passive observation leads to a more difficult information-processing task because it precludes observation of diagnostic feedback when operating in a stable, circumscribed environment. In contrast, in an active learning mode, consumers are more motivated to learn product information and their attention and engagement are more aroused. Consequently, Hoch and Deighton have concluded that active learning can promote better memory retention because information is more vivid and concrete, and because experience requires more elaborative internal rehearsal and self-generation.

Compared to a static-picture format or video formats where consumers examine products through passive observation, a VPE environment requires and encourages consumers to sample and to interact with "live" virtual products. Customers make predictions about product performance, verify their predictions, or make further inferences based on their own testing. Consequently, they can build an accurate mental representation of product performance and gain a more thorough understanding of products features. Therefore, we posit

H3a: Product presentations in a VPE format lead to higher actual product knowledge in consumers than those in a static-picture format or in video format.

Since active learning involves learning by doing, by thinking, and by actively making predictions and testing predictions, it will help consumers gain confidence in their product learning and understanding; therefore, consumers will report higher perceived website diagnosticity in a VPE format than a picture or video format. For example, Jiang and Benbasat (2005) have compared two types of VPE technologies: visual control and functional control, to static images in terms of perceived diagnosticity. *Visual control* enables online consumers to manipulate product images; *functional control*, on the other hand, enables consumers to sample the different functions of products. They have found that both visual control and functional control increase the perceived diagnosticity for their corresponding product attributes and overall perceived diagnosticity over static images. Similar findings are reported in a series of studies by Li and his colleagues (Li et al. 2002; 2003). They found that perceived product knowledge and product decision quality can be significantly heightened by 3D product experiences, compared to 2D product experiences.

H3b: Product presentations in a VPE format lead to higher perceived website diagnosticity than those in a static-picture format and in video formats.

Task Complexity as a Moderator of Diagnosticity

Our observations and prior literature have shown that a current "fashion" in e-commerce website design is to employ more and more multimedia features to decorate websites, and, in particular, to depict online products (Hong et al. 2004; Zhang 2000). Therefore, a relevant concern arises: When a task of understanding an experience product becomes highly complex, will the predicted superior effects of videos and VPE hold consistently?

According to Wood (1986), task complexity is a function of the number of distinct acts that must be completed and the number of distinct information cues about the attributes of the task-related stimulus object an individual has to process when performing a task. Prior research on task complexity has indicated that high task complexity can increase information processing requirements and demand more cognitive resources from task executors (Klemz and Gruca 2003; Speier 2003; Zigurs and Buckland 1998). If the amount of information processing exceeds a certain limit, people's cognitive capacity will likely moderate their learning performance for two reasons (Norman and Bobrow 1975). First, people's *attention* to tasks may get diluted and hence they cannot learn effectively (Kahneman 1973). Second, people may spend too much *cognitive effort* on the task and consequently simplify their task execution strategies or even sacrifice their task performance in exchange for saving effort (Todd and Benbasat 1999).

In particular, since people's attentional resources are limited (Kahneman 1973), they cannot hold their attention consistently for too long. Beyond a certain period, people may get bored with the task and thus their task performances, such as memory and recognition, are unfavorably affected (Eysenck and Keane 2000). In the context of online product presentations, in order to fully understand the experiential attributes presented in an animated video format, users have to follow its dynamic pace and remain attentive. In contrast, users can control their own pace of information acquisition when watching static pictures. Therefore, the requirement for attentional resources is more stringent in a video format than in a static-picture format. When sufficient attentional resources are available, the dynamic scene changes and product sound effects of videos grab more attention from consumers, thereby better motivating consumers' product learning than a static-picture format. However, when a product understanding task becomes highly complex, a video-based product presentation likely leads to a conflict between the amount of attention that a task demands and the amount that people's attentional resources can afford (Hong et al. 2004). In this case, the attention-grabbing effect of video formats may be dysfunctional, thereby reducing potential benefits of video formats. Therefore, we hypothesize

H4a: The superiority of video formats over a static-picture format in terms of actual product knowledge will be less prominent when product understanding tasks become highly complex.

However, in terms of perceived website diagnosticity, the moderating effect of task complexity may not function. This can be explained by the effects of "seductive experience" (Hoch 2002). Hoch contends consumers tend to over-trust and over-estimate what they have learned through experience simply because a product experience is engaging. Since video conditions incorporate more sensory cues (e.g., dynamic scene changes and product sounds) than a static-picture-based condition, it is likely that they are more engaging and entertaining (Jiang and Benbasat 2005; Raney et al. 2003). Consequently consumers in these conditions hold the perception of pseudo-diagnosticity, which is unlikely to be affected by the limitation of attentional resources. Therefore, we posit the following null hypothesis:

H4b: The superiority of videos over a static-picture format in terms of perceived website diagnosticity will not change significantly when product understanding tasks become highly complex.

Since VPE involves consumers' active learning and trial of products, it requires more proactive effort from consumers when compared to other presentation formats where consumers can passively observe product demonstrations. Therefore, for highly complex product evaluation tasks, if the cognitive demands are beyond a certain threshold, consumers would likely simplify their product try processes by taking a less active learning manner (Garbarino and Edell 1997; Todd and Benbasat 1999), for example, by reducing the depth and breadth of virtual product trials or even giving up product trial for effort saving, which would, in turn, significantly reduce the potential benefit of active learning on consumers' product understanding. Therefore, we propose

H5a: The superiority of VPE over static-picture and video formats in terms of actual product knowledge will be less prominent when product understanding tasks become highly complex.

On the other hand, task complexity is not expected to affect the superiority of VPE for perceived website diagnosticity, due to the effect of the "illusion of control." Prior DSS research has discovered people tend to overestimate their decision performance if they have control over their decision making process (Davis and Kottemann 1994; Kottemann et al. 1994). For example, Davis and Kottemann (1994) conducted two experiments to investigate the illusion of control caused by what-if analysis.[2] The first experiment found that subjects strongly believed that what-if analysis was superior to unaided decision making even though no actual performance difference was detected. The second experiment reported that subjects generally neglected a substantial advantage of a quantitative decision rule over what-if analysis even though the quantitative rule, if used, led to significant cost savings. Based on these findings, Davis and Kottemann concluded that since what-if analysis promotes users' more active involvement and control in decision making tasks, it inflates their sense of how well they perform in the task. Applying this reasoning to the context of product presentation, we argue that since VPEs allow consumers to control and interact with product demonstrations (direct manipulation), the illusion of control causes consumers to consistently overestimate their understanding of products regardless of task complexity levels. Hence, we posit

H5b: The superiority of VPE over static-picture and video formats in terms of perceived website diagnosticity will not change significantly when product understanding tasks become highly complex.

Impacts of Actual Product Knowledge and Perceived Website Diagnosticity

To further understand the impacts of actual product knowledge and perceived website diagnosticity, it is important to investigate whether or not both constructs indeed affect other aspects of consumer behavior.

The technology acceptance model (TAM) suggests that the most important determinant of technology adoption is perceived usefulness of a technology (Davis 1989). In the context of online shopping, perceived usefulness refers to the extent to which a particular website is expected to help online consumers to accomplish their shopping goals. Since one of the major goals for online shoppers is to understand product information in order to make an informed buying decision (Burke 2002), the actual effectiveness of product understanding as well as perception of the capability of websites to facilitate product understanding will positively influence perceived usefulness of websites. Therefore, we posit

H6: Actual product knowledge positively influences perceived usefulness of websites.

H7: Perceived website diagnosticity positively influences perceived usefulness of websites.

Moreover, based on TAM and its related empirical tests (Venkatesh et al. 2003), we predict that perceived usefulness of a website will lead to consumers' intended usage of websites. Hence,

H8: Perceived usefulness of websites positively influences consumers' intentions to return to the websites.

Research Method

The hypotheses proposed in the present study were tested through a laboratory experiment with a 4 × 2 design (i.e., 4 types of product presentation formats (between-subject) × 2 levels of task complexity (within-subject)). The product presentation formats involves websites designed with: (1) static-picture, (2) video-without-narration, (3) video-with-narration, and (4) virtual product experience (VPE). The task complexity was manipulated by asking each subject to perform two product understanding tasks, with a sports watch and a PDA respectively.

Experimental Website Design

In the VPE condition, users are able to launch a VPE simulator from product homepages to sample various functions of the Timex sports watch and the Palm Pilot PDA. For example, a user can press the buttons of the sports watch to set the time simply by clicking on their computer mouse. The watch will react according to users' inputs by changing the display or by emitting various sounds (see Section 4 of Appendix A). A user can also use her mouse as a stylus to add new contact addresses or appointments in the Palm Pilot (see Section 4 of Appendix B). The Palm Pilot will react as a real product does: it will change the screen and sound when the "stylus" touches the screen. For both the sports watch and the PDA, text explanations are also provided adjacent to the

[2]What-if analysis refers to "a method for manipulating a quantitative model of a business situation in which decision makers specify alternative values of decision variables and environmental assumptions, and the computer solves the model and displays predicted results" (Davis and Kottemann 1994, p. 57).

simulators, to guide users using the different functions of the products.

In the video conditions, both with and without narration, all product functions can be previewed using prerecorded videos linked from the product homepages. All of the video files are screen-captured (using software Camtasia 1.0.0) when users sample different functions of the watch and the PDA from the VPE condition. Therefore, the video conditions present the same information content as the VPE condition.

In the video-without-narration condition, text-based feature explanations are presented adjacent to a product demonstration, explaining what the video portrays (see Section 2 of both Appendix A and B). Specifically, text explanations are scrolled and highlighted in unison with the pace of the corresponding video files. This design applies the *temporal-contiguity* principle for multimedia design proposed by Moreno and Mayer (1999).[3] In the video-with-narration condition, detailed text-based feature explanations are not displayed, but narrated aloud concurrently (see Section 3 of both Appendix A and B). Narrations were previously recorded using a generic North American male voice.

In the static-picture condition, static pictures, which are screen captured from the VPE condition, are used to display the products in different functional modes (see Section 1 of both Appendix A and B). According to Mayer and Gallini (1990), *multiple* pictures that identify product parts and describe functional steps can significantly improve the performance on recall of conceptual information and creative problem solving over single pictures. Therefore, for each functional mode, multiple pictures are used to demonstrate the steps of using the particular function. Textual explanatory descriptions corresponding to images are also provided adjacent to the images.

Overall, to the best of our efforts, factual product information content is kept uniform across the different conditions. The only difference among treatments is in the presentation formats.

Task Complexity Manipulation

Jiang and Benbasat (2005) and Suh and Lee (2005) have suggested that VPE can be effectively applied only to some products that contain *experiential* attributes, which are suitable for current VPE technologies. Since sports watches and PDAs are characterized by their particular functions or operational behavior, they are suitable for VPE technology that supports *functional control* (Jiang and Benbasat 2005).

A notable difference between the two product presentations is the number of features depicted. Specifically, the PDA has 17 experiential features that can be demonstrated online, such as its address book, note pad, mail, and security tools, while the watch has only 6 experiential features, such as time setting, stopwatch and alarm. According to Miller (1956), people can hold 7 ± 2 chunks of information in their working memory concurrently (p. 32). Therefore, the watch, with its 6 features (i.e., within the upper cognitive limit of 7 ± 2) represents a condition with a moderate level of task complexity whereas the PDA with its 17 features (i.e., double the upper cognitive limit) represents one with a high level of task complexity. This manipulation of task complexity is believed to be *objective*, based on findings reported in the cognitive psychology literature, hence is generalizable to other situations as it is a measure not necessarily influenced by the characteristics of any particular experimental setting.

In addition, the average feature complexity was calculated by counting the usage steps (or action units, such as pressing a button) for each feature. On average, the PDA requires 4.8 steps to fully sample a product feature, compared to 3.7 steps for the watch. Overall, because more product attributes are involved in PDA presentation and those attributes are generally more complex to process, the product understanding task is much more complex for the PDA than for the watch (Jahng et al. 2000).

Experimental Procedures

A total of 176 subjects were recruited from a North American university campus and randomly assigned to the four interface conditions, with 44 (176/4) in each. Because two product evaluation tasks were involved in the experiment, the order by which subjects examined products was randomized, such that half of the participants in each treatment examined the sports watch first, while the other half examined the PDA first. According to power analysis for mixed design, 44 subjects for each between-subject factor group and hence 176 subjects for each within-subject factor group can assure sufficient statistical power of 0.8 for medium effect size ($f = .25$) (Cohen 1988).

We provided subjects with a benchmark to evaluate particular websites based on *adaptation theory* (Helson 1964), which

[3]The temporal-contiguity principle means that multimedia learning effectiveness will be enhanced if visual and spoken materials are temporally synchronized (i.e., presented simultaneously rather than successively).

suggests that people's judgments are based on (1) the sum of their past experiences, (2) the context and background of a particular experience, and (3) a stimulus. In the experiment, we randomly assigned subjects to different treatment conditions to ensure that the sum of the subjects' past experiences were homogeneous across conditions.[4] Additionally, if a common benchmark was provided to all of the subjects, we could be confident that the context and background of their experimental experiences were equivalent, such that the differences across different conditions were caused only by different treatment stimuli.

Therefore, before the subjects examined products in their assigned conditions, they were shown websites that demonstrated other products with static images and text. The subjects were asked to treat the sample websites as benchmarks against which to judge the experimental websites. Each subject was then directed to an assigned experiment website, and asked to examine the products as if they were shopping and deciding whether to complete a purchase. After examining products, the subjects completed questionnaires and were paid $15 each as a participation reward.

Measurement

Perceived website diagnosticity is adapted from Jiang and Benbasat (2005) and Kempf and Smith (1998) and was measured by using the following three items based on a seven-point Likert scale:

- "This website is helpful for me to evaluate the product."
- "This website is helpful in familiarizing me with the product."
- "This website is helpful for me to understand the performance of the product."

Actual product knowledge was measured by testing experimental subjects with questions related to product features. Thirteen questions were used to assess subjects' understanding about the presented sports watch; 18 questions were about the PDA. Two examples are shown below.

Example 1(Watch):

In the time-setting or alarm-setting mode, how does this watch tell users which field (e.g., day/hour/minute) they can set a value to?

A) A flashing arrow will guide users to which field is ready to receive input.
B) The corresponding field will flash.
C) An on-screen message will guide users to which field is ready to receive input.
D) An on-screen message and a flashing arrow will guide users to which field is ready to receive input.

Example 2 (PDA):

How does the Palm allow users to test the accuracy of their stylus?

A) Users can use the stylus to tap the center of a target on the screen.
B) Users can use the stylus to write some letters following an instruction
C) Users can compare their stylus to a standard stylus
D) Users can use the stylus to click on the shortcut keys on the bottom of the screen.

Actual product knowledge was calculated as the proportion of the number of correct answers over total number of questions.

Data Analysis

Subject Background Information

The 176 subjects were recruited from 12 academic faculties/schools, representing very diverse backgrounds. Among the student subjects, 92 (52.3 percent) were female and 84 (47.7 percent) were male. Six were graduate students, and the rest were undergraduates. The average age of the participants was 21.6. There was no significant difference in gender and age distribution across the four interface conditions.

In general, the subjects felt very comfortable with Internet usage (mean: 6.50/7) and were familiar with online shopping (mean: 4.74/7). No significant differences were found across the four presentation conditions regarding these two aspects. Data on subjects' familiarity with the two product categories were also collected.[5] They reported relatively higher familiarity with sports watches (mean: 3.71/7) than with PDAs (mean: 2.93/7). Again, there is no difference in terms of the two familiarity scores across the four interface conditions.

[4]Demographics analysis has supported this assumption, see "Subject Background Information" in the next section.

[5]Product category familiarity was assessed by asking "Are you familiar with sports watches (or PDAs)?" based on a seven-point Likert scale.

Results on Actual Product Knowledge

MANOVA was conducted on both actual product knowledge and perceived website diagnosticity together.[6] Results show that the treatment effects are significant ($p < .05$),[7] hence ANOVAs were further conducted on the two dependent variables separately.

For the questions used to measure actual product knowledge, we first investigated whether some of the questions were particularly suitable to be answered by some presentation formats, but not others. We calculated the interaction effect between presentation formats and questions for the accuracy of the answers to each question. Results did not yield any significant interaction effect ($p > .05$), which suggests that it is not the case that a particular presentation format is better to answer some questions but not others. This lends support to the validity of the measurement of actual product knowledge.

Repeated measure ANOVA on actual product knowledge alone yields the significant effects of presentation formats, task complexity, and the interaction between presentation format and task complexity (see Table 1).[8] The significant interaction effect suggests that the effects of presentation formats are moderated by task complexity level; therefore, it is investigated in more detail (Glass and Hopkins 1996; Huck 2000) (Tables 2 and 3). Specifically, when task complexity is moderate, the two video conditions and the VPE condition have the same level of actual product knowledge, which is higher than that of the static picture condition. When task complexity is high, the four presentation formats do not differ in terms of actual product knowledge (see Figure 2). Therefore, H1a is partially supported (only when task complexity is moderate) and H2a is rejected. H3a is partially supported only in relation to the comparison between the VPE format and static-picture format under a moderate task complexity condition. H4a and H5a are supported because under high task complexity condition, the superior effects of the video conditions and the VPE condition diminish.

[6]The insignificant Box's test suggests that the equality of variance-covariance matrices assumption is satisfied.

[7]We have also tested whether or not there was a task order effect. Specifically, we put task order as a factor in the MANOVA analysis. Results show that the effect of task order is not significant.

[8]Since there are only two levels for the within-subject factor, the sphericity assumption is not an issue here (Glass and Hopkins 1996). This is also the case for the analysis of perceived website diagnosticity.

Results on Perceived Website Diagnosticity

The Cronbach alpha of perceived website diagnosticity is 0.80, well above 0.70, the generally acceptable level for adequate internal consistency

Repeated measure ANOVA on perceived website diagnosticity suggests that presentation formats significantly affect perceived diagnosticity, while task complexity effect and the interaction effect are not significant (Table 4). *Post hoc* analysis based on Scheffe test reveals (see Table 5): (1) the two video conditions are associated with significantly higher perceived website diagnosticity than the static picture condition, thus supporting H1b; (2) the two video conditions are not different from each other in affecting perceived website diagnosticity, thus rejecting H2b; (3) the VPE condition is associated with higher perceived website diagnosticity than the static-picture and the video-with-narration condition, but is not different from video-without-narration condition, thus providing partial support to H3b. The insignificant interaction effect reveals that the effects of presentation formats on perceived website diagnosticity do not depend on task complexity level, thus H4b and H5b are not rejected. These effects are shown in Figure 3.

Before drawing conclusions, we also investigated if subjects familiarity with the two product categories influenced findings on actual product knowledge and perceived website diagnosticity. Hence the two familiarity scores were included as covariates in the repeated measure ANOVAs. Neither of the two familiarity scores was significant, which is not unexpected because the familiarity scores represent subjects general familiarity with the two product categories, rather than two particular products that were used in the experiment. Actually, our post-experiment survey showed that none of the subjects had ever used the same type of sports watch and PDA used in this study. Therefore, general product familiarity did not influence the outcomes of this study.

Impacts of Product Understanding

PLS was used to test the structural model proposed on the right-hand side of Figure 1. The measurement model was first assessed by examining (1) individual item reliability, (2) internal consistency, and (3) discriminant validity (Barclay et al. 1995). The measurement items generally load heavily on their respective constructs, with loadings above 0.8, thus demonstrating adequate reliability (Table 6). The high composite reliability and Cronbach alpha scores shown in Table 7 lend support to satisfactory internal consistency.

Table 1. ANOVA Summary Table for Actual Product Knowledge

Source	df	Mean Square	F	Sig.
Between-subjects				
Presentation Formats	3	0.16	4.70	0.00
Within-subjects				
Task Complexity	1	0.61	46.55	0.00
Task Complexity × Presentation Formats	3	0.04	3.31	0.02

Table 2. Results on Actual Product Knowledge: Multiple Comparisons of Presentation Formats for Moderate Task Complexity

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper bound
1 static picture	2	-0.12(*)	0.03	0.00	-0.22	-0.03
(mean: 0.62)	3	-0.10(*)	0.03	0.02	-0.20	-0.01
	4	-0.15(*)	0.03	0.00	-0.24	-0.05
2 video-without-narration	1	0.12(*)	0.03	0.00	0.03	0.22
(mean: 0.75)	3	0.02	0.03	0.94	-0.07	0.11
	4	-0.02	0.03	0.92	-0.11	0.07
3 video-with-narration	1	0.10(*)	0.03	0.02	0.01	0.20
(mean: 0.73)	2	-0.02	0.03	0.94	-0.11	0.07
	4	-0.04	0.03	0.62	-0.14	0.05
4 VPE	1	0.15(*)	0.03	0.00	0.05	0.24
(mean: 0.77)	2	0.02	0.03	0.92	-0.07	0.11
	3	0.04	0.03	0.62	-0.05	0.14

Table 3. Results on Actual Product Knowledge: Multiple Comparisons of Presentation Formats for High Task Complexity

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper bound
1 static picture	2	-0.04	0.03	0.66	-0.12	0.04
(mean: 0.60)	3	-0.04	0.03	0.51	-0.13	0.04
	4	-0.05	0.03	0.46	-0.13	0.03
2 video-without-narration	1	0.04	0.03	0.66	-0.04	0.12
(mean: 0.64)	3	-0.01	0.03	1.00	-0.09	0.07
	4	-0.01	0.03	0.99	-0.09	0.07
3 video-with-narration	1	0.04	0.03	0.51	-0.04	0.13
(mean: 0.65)	2	0.01	0.03	1.00	-0.07	0.09
	4	0.00	0.03	1.00	-0.08	0.09
4 VPE	1	0.05	0.03	0.46	-0.03	0.13
(mean: 0.65)	2	0.01	0.03	0.99	-0.07	0.09
	3	0.00	0.03	1.00	-0.08	0.08

Table 4. ANOVA Summary Table for Perceived Web Diagnosticity

Source	df	Mean Square	F	Sig.
Between-subjects				
Presentation Formats	3	13.09	12.11	0.00
Within-subjects				
Task Complexity	1	0.70	1.70	0.20
Task Complexity × Presentation Formats	3	0.24	0.58	0.63

Table 5. Results on Perceived Website Diagnosticity: Multiple Comparisons

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper bound
1 static picture	2	-0.58(*)	0.16	0.00	-1.03	-0.14
(mean: 5.13	3	-0.44(*)	0.16	0.05	-0.89	0.00
	4	-0.93(*)	0.16	0.00	-1.37	-0.49
2 video-without-narration	1	0.58(*)	0.16	0.00	0.14	1.03
(mean: 5.71)	3	0.14	0.16	0.85	-0.30	0.58
	4	-0.35	0.16	0.18	-0.79	0.09
3 video-with-narration	1	0.44(*)	0.16	0.05	0.00	0.89
(mean: 5.57)	2	-0.14	0.16	0.85	-0.58	0.30
	4	-0.49*(*)	0.16	0.02	-0.93	-0.05
4 VPE	1	0.93(*)	0.16	0.00	0.49	1.37
(mean: 6.06)	2	0.35	0.16	0.18	-0.09	0.79
	3	0.49*()	0.16	0.02	0.05	0.93

Table 6. Loadings and Cross-Loadings of Measures

	Perceived Website Diagnosticity	Actual Product Knowledge	Perceived Usefulness	Intentions to Return
Diagnosticity1	**0.87**	0.11	0.59	0.57
Diagnosticity2	**0.85**	0.13	0.56	0.58
Diagnosticity3	**0.83**	0.06	0.57	0.49
ProdKnowledge	0.12	**1.00**	0.15	0.19
Usefulness1	0.52	0.18	**0.86**	0.60
Usefulness2	0.53	0.09	**0.87**	0.58
Usefulness3	0.51	0.14	**0.86**	0.58
Usefulness4	0.70	0.12	**0.80**	0.67
IntReturn1	0.56	0.15	0.64	**0.85**
IntReturn2	0.56	0.22	0.61	**0.90**
IntReturn3	0.62	0.16	0.67	0.93

Note: Actual product knowledge is indicated by a single index in the PLS model (i.e., the proportion of the number of correct answers over total number of questions). Chin et al. (2003) have suggested that "when using PLS, the case of one indicator per construct is identical to performing a multiple regression with a single-indicator measure" (p. 201).

Table 7. Internal Consistency and Discriminant Validity of Constructs

	Composite Reliability	Cronbach's Alpha	Perceived Diagnosticity	Actual Knowledge	Perceived Usefulness	Intentions to Return
Perceived Website Diagnosticity	0.89	0.80	0.85			
Actual Product Knowledge	1.00	1.00	0.12	1.00		
Perceived Usefulness	0.91	0.87	0.67	0.15	0.85	
Intentions to Return	0.92	0.87	0.65	0.2	0.72	0.89

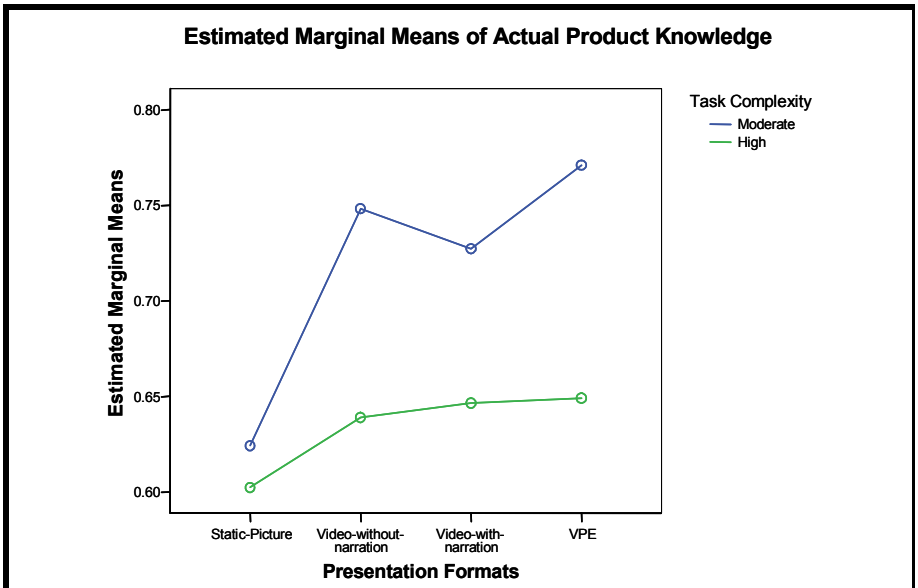

Figure 2. Results on Actual Product Knowledge

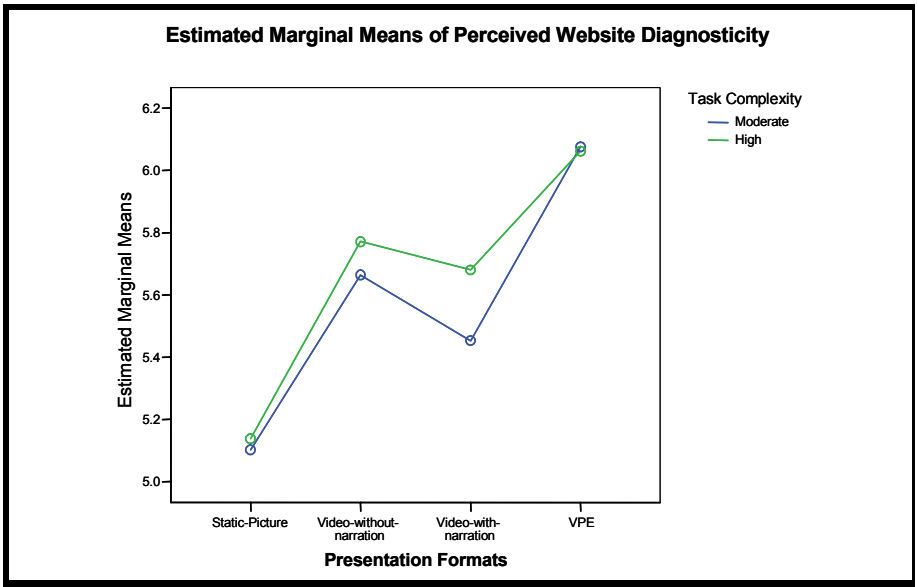

Figure 3. Results on Perceived Website Diagnosticity

Table 8. Hypotheses Testing Results

Hypotheses	Supported?	
	Actual Product Knowledge	Perceived Website Diagnosticity
H1: Superiority of video formats over static-picture formats	Partially, only for low task complexity condition	Y
H2: Superiority of video-with-narration formats over video-without-narration formats	N	N
H3: Superiority of VPE formats over alternative formats	Partially, VPE is better than the static-picture format under low task complexity condition.	Partially , VPE is better than the static-picture condition and the video-with-narration condition.
H4: The moderating effect of task complexity on the comparison between video formats and static-picture formats	Y	Not rejected
H5: The moderating effect of task complexity on the comparison between VPE formats and alternative formats	Y	Not rejected
H6: Actual product knowledge → Perceived website usefulness	N	
H7: Perceived website diagnosticity → Perceived website usefulness	Y	
H8: Perceived website usefulness → Intentions to return	Y	

The diagonal elements in Table 7 represent the square roots of average variance extracted (AVE) of latent variables, while the off-diagonal elements are the correlations between latent variables. For adequate discriminant validity, the square root of the AVE of any latent variable should be greater than the correlation between this particular latent variable and other latent variables (Barclay et al. 1995). Data shown in Table 7 therefore satisfy this requirement. Moreover, in Table 6, the loadings of indicators on their respective latent variables are higher than loadings of other indicators on these latent variables and the loadings of these indicators on other latent variables, thus lending further evidence to discriminant validity.

Bootstrap resampling was performed on the structural model to examine path significance. Results shown in Figure 4 indicate that perceived website diagnosticity has a significant and positive effect on perceived usefulness of websites[9] ($p < .05$), but actual product knowledge does not. Thus, H6 is rejected, but H7 is supported. In line with TAM, perceived usefulness also positively affects intentions to return[10] ($p < .05$), thereby supporting H8.

A summary of the outcomes of hypotheses testing is presented in Table 8.

Furthermore, as a *post hoc* exploratory analysis, we also tested whether or not actual product knowledge and perceived diagnosticity have direct effects on intentions to return to websites in the presence of perceived usefulness. Again, the results demonstrate different effects of actual product knowledge and perceived website diagnosticity. Actual product knowledge does not influence intentions directly (path coefficient = 0.08; T-statistics = 1.48; $p > 0.05$), while perceived website diagnosticity has a direct effect on intentions over and above the effect that is mediated by perceived usefulness (for perceived diagnosticity → intentions: path coefficient = 0.30; T-statistics = 3.21; $p < 0.05$; for perceived usefulness → intentions: path coefficient = 0.51; T-Statistics = 7.26; $p < 0.05$; explained variance in intentions = 0.58).

[9]Four items were adapted from Koufaris (2002) to measure *perceived usefulness*: (1) "The website improves my online shopping performance"; (2) "…improves my online decision-making in online shopping"; (3) "…increases my online shopping effectiveness"; and (4) "I find this website useful." The seven-point Likert scale was used.

[10]Three items were adapted from Coyle and Thorson (2001) to measure *intentions to return to websites*, such as (1) "Next time I need to shop for a PDA, I would like to use this website"; (2) "Next time I need to shop for a PDA as a gift for a friend, I would like to use a website with characteristics similar to those of this website"; (3) "I would use websites with similar characteristics to those of this website in the future." The seven-point Likert scale was used.

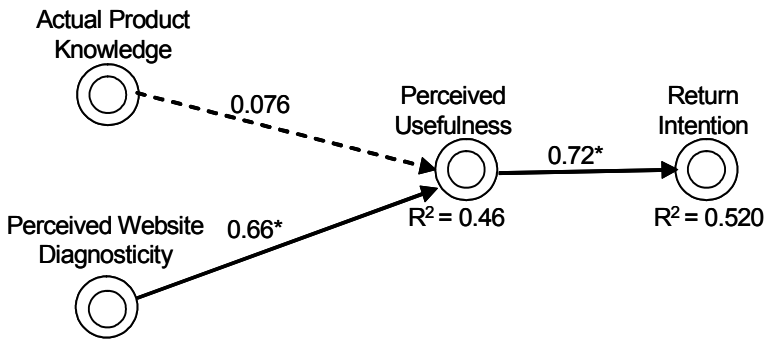

Figure 4. Nomological Network Model Testing (Full Mediation Model)

Table 9. Product Features Explored by Experimental Subjects

Group	Total Number of Features	Actual Number of Features that are Explored (Average)	Percentage of Features Explored (%)
Moderate Task Complexity (Product: Watch)			
Static-Picture	6	5.7	0.95
Video-Without-Narration	6	5.8	0.96
Video-with-Narration	6	6.0	0.99
VPE	6	5.5	0.92
High Task Complexity (Product: PDA)			
Static-Picture	17	15.5	0.92
Video-Without-Narration	17	15.5	0.91
Video-With-Narration	17	16.2	0.95
VPE	17	13.0	0.76

Additional Evidence of Effort and Product Trial

We have mentioned previously that the high effort expenditure in VPE may more likely exhaust consumers' effort capacity under high task complexity than under moderate task complexity conditions. Consequently, when using VPE, consumers are less likely to try all product features in high task complexity contexts, thus to some extent offsetting the benefits to be gained by active learning. In order to test this conjecture, we examined subjects' actual trials of different product features based on screen-captured videos of their interactions with the experiment websites (see Table 9). For the *moderate* complexity task (watch) over 95 percent of the features of the product were examined by subjects in the static-picture condition and the two video conditions, and slightly lower figure of 92 percent for the VPE condition. However, for the *high* complexity task (PDA) while over 91 percent of the features in the static-picture condition and the two video conditions were examined, only a much lower 76 percent of the features were examined in the VPE condition. Similarly, we have also analyzed the time that subjects spent in examining products under different presentation formats (details can be found in Appendix C). The results generally show that the VPE condition leads to more time per product feature than the other conditions. Overall, these data about

subjects' usage of product presentations support our earlier conjecture that active exploration is more likely to exhaust consumers' effort capacity under high task complexity conditions.

Concluding Remarks

Theoretical Contributions

This study examines the effects of various online product presentation formats on consumers' product understanding, as well as the moderating role of task complexity. We have selected and compared four typical types of product presentation formats online (i.e., using static pictures, using video-without-narration, using video-with-narration, and using VPE). To the best of our knowledge, this is the first paper in Information Systems research that provides such a comprehensive evaluation of various presentation formats on product understanding.

Recent studies in IS have investigated various web-based presentation formats on customer's learning and understanding, but their range of comparison has generally been smaller. For example, Jiang and Benbasat (2005) investigated two types of VPE, visual control and functional control, and found that both visual and functional control can increase perceived diagnosticity over picture-based product presentations. Similarly, Suh and Lee (2005) compared a VPE interface to a multiple-static-picture interface. Surprisingly, there has been a lack of substantial empirical IS studies that investigated the use of video formats in product presentations, as well as research that investigates different types of video-based presentation formats, given that using videos to demonstrate products is becoming popular in current e-commerce environments. This research contributes to this knowledge gap by putting together a static-picture format, two video formats (with- and without-narration), and a VPE format in one comparison set and by integrating theories on multimedia learning and active learning to explain the differences between these presentation formats.

In this study, we assume that one of the main goals of designing better product presentations is to promote a web store's products to consumers, that is, to effectively inform consumers of the superiority of the products a store is selling (Hoch et al. 1986; Palmer 2002). In this regard, the study has contributed to research on online product presentations by assessing both consumers' actual product knowledge and perceived website diagnosticity. While the former is clearly relevant to consumers because they want to seek product knowledge to reduce uncertainty in their purchase decisions, the latter is more relevant to online stores as they want to leverage consumers' favorable perceptions of the website's capability to attract more patronage. Our results have provided strong support to this conjecture by revealing that perceived website diagnosticity positively influences perceived usefulness of website, which, in turn, affects consumers' intentions to revisit the websites. In addition, our *post hoc* exploration has further highlighted the importance of perceived website diagnosticity by showing that it has a direct effect on intentions even in the presence of the mediating effect of perceived usefulness.

Prior studies on online product presentations have generally focused on the fit between product types and e-commerce interfaces (Burke 2002; Peterson et al. 1997; Suh and Lee 2005). These studies have argued that advanced multimedia technologies, such as videos and VPEs, are effective for presenting products that contain mainly experiential attributes; in contrast, relatively plain Internet interfaces, such as those based on static pictures and text, are effective for conveying information for products that contain mainly search attributes. The present study goes one step further by investigating, particularly for those products that consist of substantial experiential attributes, whether the predicted beneficial effects of advanced multimedia technologies, as compared to those of static pictures and text, remain constant under different task conditions.

Task characteristics and technology characteristics have been found to jointly affect task-technology fit, which further influences user performance (Goodhue and Thompson 1995; Tan et al. 1999; Zigurs and Buckland 1998). In the current study, we analyze task characteristics by using a complexity perspective. As Jahng et al. (2000) have argued, for example, in the case of evaluating complex products, a large number of product attributes may require more information processing from consumers and make the task of product understanding more complex than evaluating products that are described by fewer attributes. This study utilizes the theories on the limits on attention and cognitive effort to justify the moderating effects of task complexity and the empirical data provide considerable support for the task–technology fit theory, in particular with respect to consumers' actual product knowledge.

Practical Implications

Overall, the results of this study have provided considerable support to previous findings on the superior effects of VPE to static pictures, except for actual product knowledge under high task complexity conditions. Beyond this, this study has

yielded some new and interesting findings. In particular, it is found that videos are generally more effective than static pictures to depict products in order to help consumers understand products (except for highly complex tasks) and help them build positive perceptions toward websites. Therefore, the use of video formats to present experiential products appears a better design choice than the use of static pictures.

Contrary to our prediction based on the theory of split attention, we did not find superior product learning effects of the video-with-narration condition over the video-without-narration condition. One possible reason for the inapplicability of the split attention theory to online shopping may be due to the fact that consumers' desire for autonomous shopping is also restricted by the speed of narration in the video-with-narration condition. In order to acquire product information, consumers have to follow concurrent narrations and adapt their reading speed to the narration speed, therefore their natural thinking is interrupted and they cannot actively and attentively construct their own mental representations based on their autonomous learning practices. Overall, the negative effects caused by narrations may counteract the positive effects that are predicted based on the theory of split attention, resulting in no significant differences between the two video conditions.

The findings also indicate that videos can largely perform as well as VPE in terms of both perceived and actual understanding. In fact, the only difference observed is that the VPE condition leads to higher perceived website diagnosticity than the video-with-narration condition. The lack of substantial superiority of VPE over videos on product learning casts some doubts on the applicability of the active learning theory for comparing between VPE and video demonstrations. It appears that ready-to-watch video clips to demonstrate product information are good enough for product learning. Therefore, given that the design of VPE is more costly than that of video due to the addition of the interactivity features, designers should seriously consider the choice of demonstrating online products in a video format instead of a "luxurious" VPE format, if their ultimate goal is to improve consumers' product understanding. Nonetheless, VPE is still influential in improving variables such as perceived diagnosticity and perceived usefulness that determine intentions to return.

Limitations

As previous studies (Jiang and Benbasat 2005; Li et al. 2001) have suggested, there are many different types of VPE. The particular VPE technology that was chosen in the experiment is *functional control*, and the corresponding experimental products chosen have functionality as one of their main features; therefore, the findings are most appropriately generalizable to presentation design for similar types of products. Also, among the four experimental conditions used in the current experiment, the static-picture condition does not incorporate any sound effect while the other three conditions do. Therefore, it is possible that if auditory effects are properly integrated with static pictures, the learning effectiveness in the static-picture condition may be enhanced.

In this study, we have selected two product evaluation tasks, namely, the evaluation of a watch and a PDA, respectively, as task complexity manipulation. It should be noted that the two tasks are different in their specific contents (i.e., product information) in addition to complexity. Therefore, strictly speaking, we cannot attribute consumers' product understanding differences related to the two tasks exclusively to the complexity manipulation. However, given that the two product evaluation tasks are similar in nature in that they both focus on evaluation of electronic functionality, and it is theoretically impossible to select two products that contain exactly the same product information while being associated with different levels of complexity, we believe that our task complexity manipulation is acceptable.

Notwithstanding, the moderating effects of task complexity are not expected to be generalizable to all task complexity ranges (from very low to very high). In explaining why, two conditions should be considered. The first is that as task complexity increases, higher numbers of *experiential* attributes will be understood by consumers using video and VPE, hence product understanding will improve. The second condition is that the more complex a task, the more attentional resources or cognitive effort required to handle it, thereby lowering product understanding performance. The first condition holds true when task complexity is relatively low to moderate, that is, *before* attentional resources or cognitive efforts reach customers' capacity limitations; while the second holds true when task complexity is high and attentional resources or cognitive efforts have *exceeded* customers' capacity thresholds. Therefore, there likely exists an inverted-U-shaped relationship between task complexity and product understanding.

This particular study is motivated by our observations of the current design "fashion" that online product presentations are at times *overloaded* with a number of multimedia-based features. Therefore, this study has compared a highly complex task (i.e., examining a PDA with 17 experiential features) to a task with moderate complexity (i.e., examining a sports watch with 6 experiential features) and found that high

task complexity can reduce the beneficial effects of video and VPE formats on actual product knowledge. However, it is possible that when task complexity is at a lower range, an increase in task complexity could enhance the superiority of videos and VPEs on product understanding until attention and cognitive effort demands reach one's capacity thresholds. As such, another study that includes low, moderate, and high complexity conditions would be able to reveal the moderating effects of task complexity more comprehensively.

Two indicators of consumers' product understanding are adopted in the study: perceived website diagnosticity and actual product knowledge. However, the meanings of these two concepts are not exactly opposite to each other. While actual product knowledge measures consumers' actual understanding of product information as influenced by different presentation formats, perceived website diagnosticity represents consumers' perception of a website's capability, as influenced by different presentation formats, to help them understand products, rather than consumers' perception of how much they understand products. Therefore, these definitions of the constructs used should be kept in mind when interpreting the findings of this study.

Future Research

This study has investigated the effects of static pictures, videos, and VPE product demonstrations on consumers' product understanding. In general, we have found relatively weak evidence of the superiority of VPE over video conditions on consumers' product understanding. The results do not justify the popularity of VPE in current e-commerce websites and should prompt future research to look at the impacts of these product presentation formats on other aspects of consumers' product experience. Previous studies, for example, have generally suggested the importance of hedonic influences in shopping (Babin et al. 1994) as well as in information systems usage (Koufaris 2002; van der Heijden et al. 2001). It would, therefore, be interesting to examine whether VPE can provoke more consumer curiosity, interest, and enjoyment in product features than video conditions. If so, VPE applications may justify their importance; otherwise, designers should conduct a cost-benefit analysis for VPE as its design generally requires more efforts from the designer (e.g., to design and implement product interactivity) than video-based product presentations. Another important aspect of consumers' online product experience is their attention on product features. We mentioned earlier that video-based product presentations can grab more attention from consumers than static product pictures. However, our study did not capture the amount of attention consumers devoted to product evaluation. Future studies may want to explore this research opportunity and identify some interesting patterns about consumers' allocation of attentional resources.

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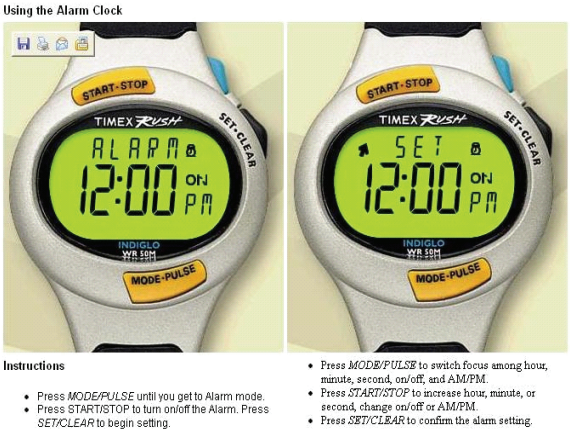
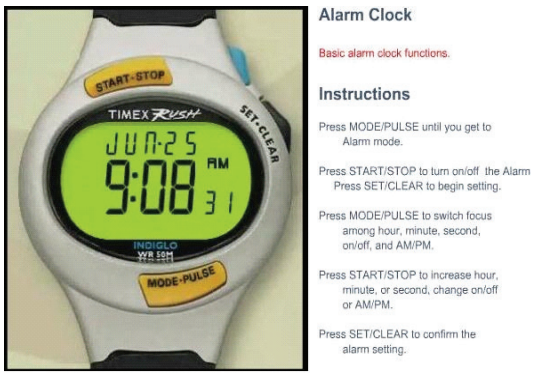
Appendix A

Moderate Task Complexity (Product: Sports Watch; Illustrative Function: Alarm) [redacted]

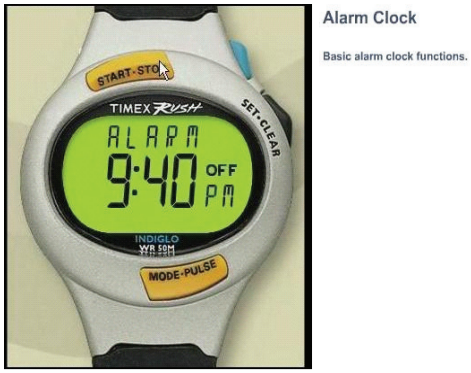
(1) Static Picture Condition



(2) Video-Without Narration Condition



(3) Video-with-Narration Condition



(4) VPE Condition

Appendix B

High Task Complexity (Product: PDA; Illustrative Function: Note Pad) [redacted]

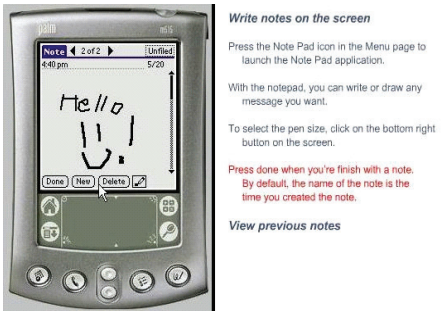
(1) Static Picture Condition

- Press the Note Pad icon in the Menu page to launch the Note Pad application.
- Press **New** to create a note.
- With the notepad, you can write or draw any message you want.
- Press ***done*** when you're finish with a note.
- By default, the name of the note is the time you created the note.

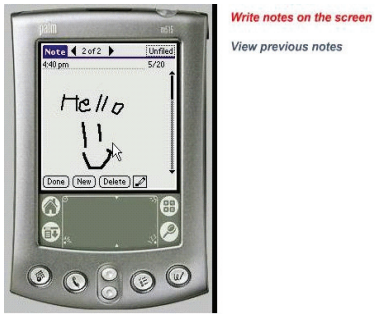
- To select the pen size, click on the bottom right button on the screen.

- To review a note, just click onto the note's name.

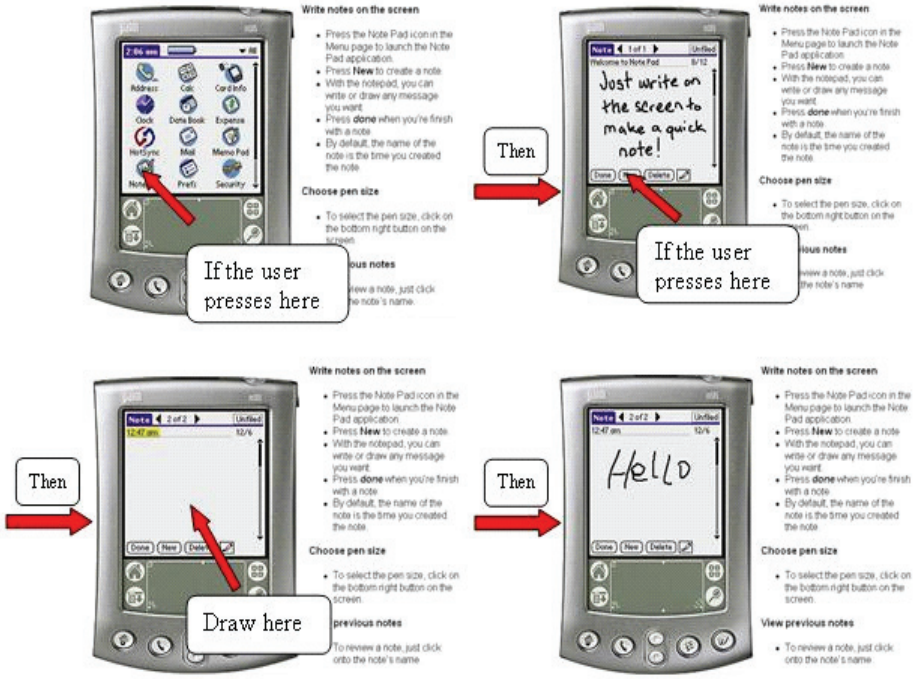
(2) Video-Without-Narration Condition



(3) Video-with-Narration Condition



(4) VPE Condition



Appendix C

Analysis of Time Spent on Examining Products

Repeated measure ANOVA was performed to examine how presentation formats and task complexity affect the time that subjects spent on examining products. Results show that the two main effects and the interaction effect are all significant (see Table C1). Since the significant interaction effect suggests that the effects of presentation formats are moderated by task complexity level, it is investigated in detail.

In particular, under the moderate complexity condition (see Table C2), the static-image, video-without-narration, and video-with-narration are at the same level. The VPE is associated with more time than static-image and video-without-narration, but the same amount of time as video-with-narration. With respect to the comparison between VPE and video-with-narration, note that there is a mean difference (in minutes) between VPE and video-without-narration, and keep in mind that the Scheffe test used to detect significant differences for a family of contrasts is very conservative. Also, note that under the moderate complexity condition, more features were explored by video-with-narration subjects than by VPE subjects (99 percent versus 92 percent; see Table 9).

Under high complexity condition (see Table C3), the two video conditions and the VPE condition are at the same level, all higher than the static-image condition. Since subjects use significantly fewer product features in the VPE condition than the other three conditions, as reported in Table 9, the time per feature for VPE is much higher than others.

Table C1. ANOVA Summary Table for Time Spent on Examining Products (Unit: Minutes)

Source	df	Mean Square	F	Sig.
Between-Subjects				
Presentation Formats	3	569.52	13.26	0.00
Within-Subjects				
Task Complexity	1	5858.91	254.71	0.00
Task Complexity × Presentation Formats	3	142.51	6.20	0.00

Table C2. Results on Time Spent on Examining Products (Unit: Minutes): Multiple Comparisons of Presentation Formats for High Task Complexity

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper bound
1 static picture (mean: 6.64)	2	-1.16	0.83	0.58	-3.49	1.17
	3	-2.00	0.83	0.12	-4.33	0.33
	4	-3.57(*)	0.83	0.00	-5.91	-1.23
2 video-without-narration (mean: 7.80)	1	1.16	0.83	0.58	-1.17	3.49
	3	-0.84	0.82	0.79	-3.14	1.47
	4	-2.41(*)	0.82	0.04	-4.72	-0.09
3 video-with-narration (mean: 8.65)	1	2.00	0.83	0.12	-0.33	4.33
	2	0.84	0.82	0.79	-1.47	3.14
	4	-1.57	0.82	0.30	-3.89	0.75
4 VPE (mean: 10.22)	1	3.57(*)	0.83	0.00	1.23	5.91
	2	2.41(*)	0.82	0.04	0.09	4.72
	3	1.57	0.82	0.30	-0.75	3.89

Table C2. Results on Time Spent on Examining Products (Unit: Minutes): Multiple Comparisons of Presentation Formats for Moderate Task Complexity

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower bound	Upper bound
1 static picture (mean: 11.18)	2	-5.02(*)	1.53	0.02	-9.32	-0.70
	3	-8.03(*)	1.53	0.00	-12.35	-3.71
	4	-8.44(*)	1.54	0.00	-12.78	-4.09
2 video-without-narration (mean: 16.20)	1	5.02(*)	1.53	0.02	0.07	9.34
	3	-3.01	1.52	0.27	-7.31	1.29
	4	-3.42	1.53	0.18	-7.73	0.90
3 video-with-narration (mean: 19.21)	1	8.03(*)	1.53	0.00	3.71	12.35
	2	3.01	1.52	0.27	-1.29	7.31
	4	-0.41	1.53	1.00	-4.73	3.91
4 VPE (mean: 19.61)	1	8.44(*)	1.54	0.00	4.09	12.78
	2	3.42	1.53	0.18	-0.90	7.74
	3	0.41	1.53	1.00	-3.91	4.73