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Analogies and Mental Simulations in Learning for Really New Products: The Role of Visual Attention

Stephanie Feiereisen, Veronica Wong, and Amanda J. Broderick

Really new products (RNPs) create new product categories or at least significantly expand existing ones. The development of RNPs is a strategic priority for most companies. However, 40% to 90% of new products fail, often due to consumers' lack of understanding of product features and benefits. Learning strategies, such as analogical learning and mental simulation, can help consumers understand the benefits of RNPs and thus may contribute to the successful development of marketing campaigns. Moreover, the presentation format of marketing communications is likely to influence consumers' understanding of the product. Pictorials have the potential to convey novel information without overloading the decision maker and thus may be a more efficient way to present information about RNPs than words. This paper contributes to a better understanding of consumer information processing in learning for RNPs. Study 1 examined the impact of (1) learning strategies (analogical learning vs. mental simulation) and (2) presentation formats (words vs. pictures) on product comprehension. Study 2 used an eye-tracking experiment to assess how respondents' visual attention patterns may affect product comprehension. Study 1 showed that the use of words in marketing communications for RNPs is generally more effective to enhance product comprehension than the use of pictorials. However, the video glasses were a notable exception as the combination of mental simulation and pictures yielded a high comprehension level for this product. This suggests that the use of pictorials may be appropriate to convey information for products of a more hedonic as opposed to utilitarian nature. Study 2 used a combination of eye-tracking measures and self-reports to help illuminate the cognitive processes at work when consumers learn new product information. The results suggest that an increase in attention to an element of the advert can account for one of two underlying processes: (1) an increase in comprehension; or (2) a difficulty to understand product information which may result in consumer confusion. This study adds evidence to a growing body of literature that demonstrates the power of learning strategies such as mental simulation and analogical learning in preparing consumers for new product acceptance. The use of visual stimuli contributes to the debate on the effectiveness of words versus pictures, seldom applied in a new product development (NPD) context. These findings are integrated into a discussion of the managerial implications and the potential avenues for future research in the area.

Introduction

Really new products (RNPs) create new product categories or significantly expand existing ones (Gregan-Paxton et al., 2002). They

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allow consumers to do something they have never been able to do before and thus differ considerably from incremental innovations that simply build on established products (Garcia and Calantone, 2002). The development of RNPs is a strategic priority for most companies since, without the success of RNPs, market shares ultimately drop off, consistent with product life cycle predictions (Hoeffler, 2002). Examples of RNPs that have succeeded in the marketplace include digital cameras, personal digital assistants (PDAs) and MP3 players. However, most technology-based innovations are not as successful as these. In fact, 40% to 90% of new products fail, and highly innovative products fail at an even greater rate than less innovative products (Cierpicki, Wright, and Sharp, 2000). Designing a marketing communications campaign that helps consumers understand truly novel or complex innovations is a key challenge for marketers (Gregan-Paxton et al., 2002). Despite the considerable sums companies spend on new product advertising, understanding learning processes specific to RNPs as well as the implications for communication message strategy remains low. Recent academic work suggests that traditional consumer learning processes like categorization (Meyers-Levy and Tybout, 1989) are inadequate to explain learning for RNPs, as these products defy classification using consumers' existing cognitive categories (Lehmann, 1994). A recent stream of literature has identified a learning strategy that facilitates the comprehension of RNPs: analogies (e.g., Ait El Houssi, Morel, and Hultink, 2005; Gregan-Paxton et al., 2002).

The knowledge-transfer paradigm indicates that the successful use of analogies from existing knowledge bases aids the comprehension of new product concepts (Moreau, Lehmann, and Markman, 2001). However, although the recent literature on learning for RNPs has focused on analogical learning, a further learning strategy is likely to enhance consumer comprehension of RNPs: mental simulation (Hoeffler, 2003). Although mental simulation has been studied in the context of consumer new product evaluation (Dahl and Hoeffler, 2004) and the measurement of preferences for RNPs (Hoeffler, 2003), the potential of mental simulation as a learning aid in marketing communications for RNPs has received little attention. Moreover, past research has examined only consumer responses to advertising for RNPs conveyed by text. However, pictorials have the potential to convey novel information without overloading the decision maker (Tegarden, 1999) and may be a more efficient way to present information about RNPs. Therefore, determining whether learning processes rendered by pictorials may be more effective is a timely endeavor.

To reduce the uncertainty involved when trying to explain consumer cognitive responses to RNPs, it would be useful to understand how attention to marketing communications contributes to comprehension or confusion toward the product. The combination of self-reports and physiological measurements (i.e., eye-tracking technique) may enhance the understanding of the dynamics that link conceptual analysis (during which consumers integrate information from the stimulus with their existing knowledge; Pieters and Warlop, 1999) and perceptual analyses (during which individuals integrate textual and pictorial information using visual attention; Rayner et al., 2001).

The aims of this study are, therefore, to determine which learning strategy (analogy vs. mental simulation) and which presentation format (words vs. pictures) are most effective in enhancing comprehension of RNPs and to illustrate how visual attention to

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a marketing communication may affect learning outcomes.

Theoretical Background

Researchers in a variety of fields including psychology (Gentner, 1980, 1982; Holyoak, 1985), instruction (Halpern, Hansen, and Roefer, 1990), and politics (Spellman and Holyoak, 1992) have examined the value of analogies as an aid to learning new concepts. Researchers in psychology build on the structure-mapping theory of analogy (Gentner, 1989) to define an analogy as the mapping of knowledge from one familiar domain (the base) onto an unfamiliar, unknown domain (the target). Analogical transfer involves three steps: (1) access; (2) mapping; and (3) transfer. Access refers to the retrieval of the base from long-term memory. During mapping, structural similarities between the base and target are identified and the commonalities in the domains are aligned (Gentner and Markman, 1997). Alignment and mapping allow for the production of inferences transferred from the base to the target. Based on the similarities of the unknown domain to a familiar domain (e.g., an existing product), the individual draws conclusions on the nature of the unknown concept (e.g., the RNP). A key characteristic of an analogy is that common relations are essential but that physical similarities are not (i.e., the base and the target do not look alike).

Drawing on this body of work, recent research has turned to analogies to explain learning for RNPs (Ait el Houssi et al., 2005; Gregan-Paxton and Roedder-John, 1997; Moreau et al., 2001; Roehm et al., 2001). Consumers are unlikely to spontaneously activate their existing knowledge structures to learn about RNPs, simply because these novel innovations are like nothing they have seen or experienced before (Lehmann, 1994). The use of an analogy to compare the RNP (i.e., target) with an existing, familiar domain (i.e., base) provides the structural knowledge needed to elaborate on new product information. This point is perhaps best illustrated by a concrete example. Nike recently teamed up with Apple to launch the Nike + iPod Sport kit, a pedometer system designed to give runners feedback on their workout (Champagne, 2007). This system has been compared to a "coach" (Anonymous, 2007). This analogy underlines that the kit will be similar to a coach in some respects. For instance, as a coach gives feedback on one's progress from one training to another, one may infer that the kit possesses a similar progress-tracking function. This mapping occurs despite the evident lack of physical similarity between the two but makes sense when one considers that the RNP and the coach occupy the same role in the common relational structure, linking the coach to the product (i.e., both of them help an individual in his or her daily workout).

Academic interest in analogical learning has been largely confined to verbal analogies (Gregan-Paxton et al., 2002; Roehm et al., 2001). However, due to the ever-increasing space dedicated to pictures in print ads, research on how visual elements persuade is warranted (Pracejus, 2003). The science of pragmatics is concerned with the study of meaning as it arises from language occurring in context. It distinguishes between two meanings: the meaning intended by the communicator and the meaning understood by the receiver (Leech, 1983; Sperber and Wilson, 1986). This leads to a key issue for the development of marketing communications for RNPs. Due to the complexity of such products, there is a risk that consumers may not understand the meaning of the ad and thus may not fully comprehend the nature of the product. Two types of inferences may be drawn from a claim: strong and weak implicatures (Sperber and Wilson, 1986). Strong implicatures call for one interpretation that varies little across individuals. Contrarily, weak implicatures yield a wider range of inferences. A product description using text usually stimulates strong implicatures, whereas one using pictures can fuel a range of weak implicatures, as visuals tend to be opened to multiple interpretations (McQuarrie and Phillips, 2005). Therefore, the use of text should ensure that the meaning intended in the advertisement is understood by all individuals. In contrast, information conveyed using pictures may be interpreted differently across individuals.

Analogies rely on inferences, cognitive processes whose unique characteristic is to go beyond the given information (Fishbein and Ajzen, 1975). Importantly, the inferences that arise from analogical transfer are only guesses and may not convey an accurate representation of the target product (Gentner and Markman, 1997). Past research on RNPs has shown that verbal analogies can be effective learning strategies for RNPs but also run the risk of misinforming consumers (Hoeffler, 2003). Using a visual analogy instead of a verbal analogy should increase this risk as one of the main syntactic properties of visual communication is its lack of explicit means to identify how images relate to each other (Messaris, 1997). Words can explicitly

evoke an analogy between two products, whereas visuals do not have an equivalent type of syntax to express analogies. Moreover, the wide range of inferences induced by pictures (McQuarrie and Phillips, 2005) increases the risk that subjects reach an inappropriate conclusion about the nature of the RNP. This is consistent with the finding that inferential beliefs derived from pictures are weaker than those derived from text (Smith, 1991). Thus,

H1a: The analogical learning strategy is more likely to increase product comprehension when it is conveyed by words than by pictures.

Advertising often encourages consumers to mentally imagine using a new product. Recently, the "Samsung imagine" campaign invited consumers to imagine owning the most mobile computer in the world or to imagine lying around with the world's lightest 14 inch mobile computer. Like analogical learning, mental simulation is another learning strategy that can help individuals deal with uncertainty and knowledge development (Taylor et al., 1998). Mental simulation is defined as the imitative mental representation of some event or series of events (Taylor and Schneider, 1989). The use of mental simulation as a learning strategy for product evaluations is well established (Phillips, 1996; Shiv and Huber, 2000). Conceptually, mental simulation is closely related to MacInnis and Price's (1987) notion of preconsumption mental imagery, where the consumer vicariously experiences product use prior to actual consumption. Similarly, Walker and Olson (1997, p. 159) explained how consumers form "visual images of certain product-related behaviors and their consequences" to "vicariously experience the consequences of product use." Phillips (1996) referred to the notion of "consumption visions." A consumption vision consists of a series of mental images of product-related behaviors, which allows consumers to anticipate the actual consequences of product use (Phillips, Olson, and Baumgartner, 1995; Walker and Olson, 1997).

Two antecedents are expected to trigger mental simulation: the use of pictures and the use of text with instructions to imagine (Babin and Burns, 1997). A pictorial description of the consumption experience is likely to help consumers anticipate what the actual consumption may be like (Miniard et al., 1991). Mental simulation is expected to consist of two main components: the self and the consumption situation. If the situation is presented in the advertisement using a visual scenario, one half of the foundation for the mental simulation is established. All the individual has to do is to imagine himself or herself in that situation (Phillips, 1996). Moreover, mental simulation can be triggered by an explicit instruction to imagine. Such an invitation should greatly facilitate the construction of a mental simulation scenario. This is supported by one study that found that compared with subjects who were not given explicit instructions, subjects who did receive these instructions imagined more complex mental images and more detailed product attributes (McGill and Anand, 1989).

However, the impact of mental simulation stimulated using words versus pictures in the context of learning for new product concepts has not been investigated to date. The sensory–semantic model developed in cognitive psychology (Nelson, 1979) argues that pictures have a superiority effect over words on learning. This model posits that stimuli are represented in memory in terms of distinctive features: sensory (i.e., visual or appearance features) and semantic (i.e., meaning or significance). The sensory–semantic framework explains the picture-superiority effect by pictures' encoding distinctiveness at the level of processing. Pictures are composed of lines and curves that are more distinctive than the lines and curves that compose words. This enables pictures to be encoded more distinctively than words—hence, a more distinct memory trace. This seminal work in cognitive psychology enhances our understanding of picture versus word effect on learning. However, this work focuses on the effect on memory trace and recall. A question is whether the picture-superiority effect on memory holds for the comprehension of new product concepts. The sensory–semantic model sheds light on a key issue related to pictures. Using pictures to stimulate imagery in the depiction of a new product may drive individuals to focus on the sensory aspects of the product (appearance features) and to pay less attention to the meaning of the product functions. On the contrary, individuals may focus less on the product appearance when the advertisement uses words, may access the semantic level of the product meaning instead, and thus may reach a higher product comprehension. Furthermore, research in semiotics argues that using mental simulations conveyed by pictures cannot include explicit arguments (Messaris, 1997)—hence, a risk that consumers lack guidance to merge the RNP with their usage patterns. Contrarily, the explicitness of verbal syntax may help consumers to vicariously experience the self-relevant consequences of product use (Walker and Olson, 1997). Therefore,

H1b: The mental simulation strategy is more likely to increase product comprehension when it is conveyed by words than by pictures.

Although verbal analogies are recognized in consumer research and psychology as a valuable strategy in the acquisition of new knowledge, marketers should exercise caution in the use of analogies. Analogies are only guesses, and the inferences resulting from analogical transfer may be false, which is an inherent risk of analogical processing (Gentner and Markman, 1997). Thus, analogies run the risk of misinforming consumers. Researchers in advanced knowledge acquisition argue that analogies, by reducing concepts to a simpler and more familiar core, may prevent individuals from attaining the "mastery of complexity," or the acquisition of those aspects of conceptual complexity that are necessary for a correct understanding of important concepts (Spiro, Feltovitch, and Coulson, 1988). Well-intended analogies, in an attempt to simplify complex concepts, may result in oversimplified knowledge, as the incomplete representation offered by the analogy often remains the only representation of the target concept. Two types of misconceptions about the nature of the target may arise: overextensions and omissions (Spiro, Feltovitch, and Coulson, 1988). Overextensions occur when a salient characteristic of the base domain that has no analog in the target domain is nevertheless exported to the target. In the analogy between the Nike + iPod kit and a coach, a consumer may erroneously infer that the product has a feature to keep him or her motivated in the long term, as a coach would do. Omissions take place when an important characteristic of the target domain has no counterpart in the base domain, and that missing characteristic does not get incorporated in the understanding of the target. In the analogy between the Nike + iPod kit and a coach, a consumer may not realize that the kit has a feature that can track the calories burned as you run, as the coach may usually only track the time and distance run.

Mental simulation is as an appropriate strategy to help individuals deal with knowledge development (Sujan et al., 1997) and uncertainty (Taylor et al., 1998). The need to use mental simulation to imagine a situation of product use may be higher for discontinuous products like RNPs than for regular products, as there is a need to link the product to consumer goals and to assess the consequences of product use (Oliver, Robertson, and Mitchell, 1993). Mental simulations for RNPs are likely to stimulate understanding of the RNP's fit with existing usage habits (Taylor et al., 1998), thus increasing the perceived product compatibility (Rogers, 1995) and decreasing uncertainty (Hoeffler, 2003). Mental simulation may provide "experience value" (Kahneman and Tversky, 1984) when product trial is impossible, as it often is for RNPs: Product trial in the consumer's mind is used as a proxy for experience. This is consistent with the finding that a mental simulation in a preference measurement exercise for RNPs led to improved accuracy in measuring actual preferences for RNPs and enabled respondents to develop a more accurate estimate of the product's utility than did analogies (Hoeffler, 2003). Thus,

H2a: When the learning strategies are presented using words, the mental simulation strategy is more likely to increase product comprehension than the analogical learning strategy.

Words and sentences can explicitly create a link or evoke an analogy between two products. On the contrary, pictures do not have an equivalent of this type of syntax to express analogies (Messaris, 1997). For incremental new products, the use of visual analogy is likely to enhance persuasion and recall. Because consumers have significant stored knowledge structures for existing product categories, they can easily infer from a visual analogy what the advertised benefits of the product are. However, what happens when a visual analogy is used to advertise a product for which consumers do not have existing knowledge structures? Visual analogies use images put in parallel, which can evoke different meanings: analogy, causality, or some other relationship (ibid.). Thus, arguments using an analogy through the sole use of images cannot be completely explicit. This indeterminacy is likely to hinder consumer comprehension in the context of learning for RNPs, as consumers may lack assistance to understand the link between the new product and the base. For instance, a visual analogy showing a picture of the Nike + iPod kit next to a picture of a coach may confuse respondents as this may indicate that the new product is like a coach but also could drive them to believe that the product is used by a coach. Additionally, a visual analogy has no explicit starting point; in the case of an analogy between a RNP and an existing product, the viewer may not know for sure whether it is the base or the target that is the focus of the advertisement (ibid.).

However, visual mental simulation has long been identified as a key mechanism in learning (Rossiter, 1982). Childers and Houston (1984) identified imagery as a powerful mediator for learning, which is significantly improved by the use of pictures. The visual representation of product use takes the form of a scenario within which pictures create relationships between the steps of product trial so that comprehension is encouraged. Little attention has been paid in consumer research to the impact of visual analogies and visual mental simulation on the comprehension of new product concepts. This is surprising due to the strong potential of visual mental simulations to act as a surrogate for a product-in-use demonstration of RNPs, especially as these brand-new products may not always be available for demonstrations. Overall, mental simulation strategies conveyed by pictures benefit from a high interactivity, as they show the product in use and may generate more open-ended thinking about the product's benefits; contrarily, visual analogies do not show the product in use and may lead to inferences that are related to the properties only that the new product shares with the analog base (Hoeffler, 2003).

H2b: When the learning strategies are presented using pictures, the mental simulation strategy is more likely to increase product comprehension than the analogical learning strategy.

Figure 1 summarizes the study's conceptual framework.

Study 1

Design and Sample Characteristics

The study was conducted among 602 participants from a British university who completed an online questionnaire in exchange for a chance to win an MP3 player. The sample consisted of 43% males and 57% females within an 18- to 56-year-old age range. Respondents were divided into six groups. There were 84–102 participants in each cell of this 2 (learning strategy: mental simulation vs. analogy) × 2 (presentation format: words vs. pictures) × 3 (product: video glasses vs. Digipen vs. intelligent oven) mixed design. The design is shown in Table 1.

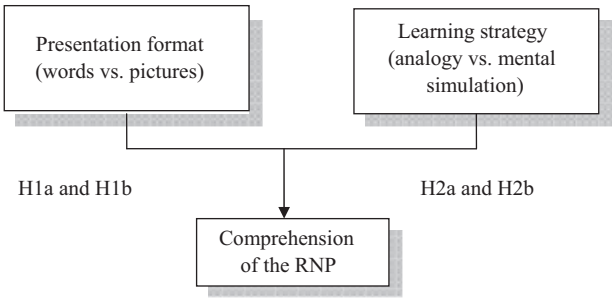

Figure 1. Conceptual Framework

Table 1. Design of Study 1

Group	Stimuli 1	Stimuli 2
1	Visual mental simulation Intelligent Oven ($N = 100$)	Visual analogy Digipen ($N = 99$)
2	Visual mental simulation Video Glasses ($N = 95$)	Visual analogy Intelligent Oven ($N = 84$)
3	Visual mental simulation Digipen ($N = 102$)	Visual analogy Video Glasses ($N = 99$)
4	Verbal mental simulation Intelligent Oven ($N = 102$)	Verbal analogy Digipen ($N = 99$)
5	Verbal mental simulation Video Glasses ($N = 102$)	Verbal analogy Intelligent Oven ($N = 100$)
6	Verbal Mental Simulation Digipen ($N = 101$)	Verbal Analogy Video Glasses ($N = 101$)

Participants were first asked to fill in demographic measures. Then, they read the first advertisement carefully, at their own pace. Following this, the participants were instructed to fill out the questionnaire containing the dependent variables. The latter steps were repeated for the second advertisement.

Not every respondent was able to complete the two questionnaires, resulting in a total of 1,184 cases. Advertisement types were presented in balanced orders to reduce carryover effects. Three RNPs were chosen: the Video Glasses (i.e., a headset that enables the viewer to watch videos downloaded on a mobile on a large screen), the Intelligent Oven (i.e., an oven that also works as a fridge and can be programmed remotely to start cooking), and the Digipen (i.e., a pen that transforms handwritten notes into electronic documents). At the time of the study, the products qualified as RNPs in that they required both the consumer and the organization to think differently in producing and using the new product (Lehmann, 1994). Three analogical bases were selected (Video Glasses: cinema projector; Intelligent Oven: cook, Digipen: secretary).

Stimuli

Twelve print advertisements were developed. All the advertisements contained a headline at the top, the

brand name at the bottom, and a list of three product features. Hypothetical brand names that conveyed minimal information about product attributes were selected so inferences were necessarily based on the contents of the stimulus ads rather than on prior knowledge or attitudes about existing brands. To construct the verbal analogy condition, a small picture of the product was placed at the top of the ad, followed by a verbal description of the product, starting with an analogy using words such as, "The E-2000 is like a cinema projector." Two additional references to the base were made to stimulate analogical transfer in the text (e.g., "gives the impression of watching videos projected on a cinema screen" and "similar to a cinema projection"). The verbal mental simulation was identical except for changes in wording to stimulate mental imagery instead of analogical transfer. Mental simulation using words was stimulated using instructions to imagine and concrete words (Babin and Burns, 1992) (e.g., "Imagine yourself using the E-2000"; "Movies from your last ski trip? Last concert?"; "Just imagine . . ."). To construct the visual analogy version, a large picture of the RNP was related to a picture of the base domain (e.g., a cinema projection). The visual mental simulation contained a visual scenario of product use intending to stimulate mental imagery with concrete pictures. Ad layout was held constant across products to improve internal validity by controlling for extraneous sources of stylistic variation.

Pretests

In a first pretest, 10 marketing expert judges were interviewed as a panel with the aim to ascertain the validity of the visual versus verbal manipulation. First, it was established that all the pictures of the base domains used in the visual analogies were easy to identify. Each judge was shown a picture of each base domain and was asked, "If you had to describe this picture using one sentence, what would you say?" A 100% agreement was reached across judges, indicating that the pictures of the base domains were easily identifiable as a cook, a secretary, and a cinema projection. Feedback was also collected from the judges to confirm that these pictures were all viewed positively. Second, the judges were given the three ads containing a visual mental simulation and the three ads with a visual analogy and were asked, "If you were given the assignment of conveying the message of the pictorial element into words, what would you say? Please try and provide a detailed explanation." The descriptions of the experts were used to improve the similarity between the message conveyed in the visual and the verbal conditions. Third, the expert judges were shown both the visual and verbal conditions. The experts' suggestions about how to increase the similarity of the message conveyed visually and verbally were solicited, and the stimuli improved based on these suggestions.

A second pretest was conducted among 53 respondents drawn from a student population. The second pretest aimed to ensure the validity of the product choice manipulation. First, to ascertain that the respondents had limited familiarity with the products and that the products did not significantly differ in terms of familiarity, participants were asked to indicate their familiarity with the products using a seven-point scale (not very = 1; very = 7). As expected, the three products all rated low in familiarity and did not significantly differ in terms of respondents' familiarity ($mean._{video\ glasses} = 2.68$; $mean._{intelligent\ oven} = 2.22$; $mean._{Digipen} = 2.92$; $p > .05$ on a seven-point scale). This suggested that participants had limited existing cognitive structures for the products. The validity of the analogical base manipulation was then ascertained. The analogies should have similar abilities to transfer the structural knowledge needed to form a meaningful representation of the new product (Gregan-Paxton et al., 2002). Participants were asked to rate how easy it was to understand the comparison between the base and the target, using a seven point-scale (not easy at all = 1; very easy = 7). The pretest showed that the ease of understanding the analogy between base and target did not significantly differ across products ($mean._{video\ glasses} = 4.12$; $mean._{intelligent\ oven} = 4.71$; $mean._{Digipen} = 4.92$; $p > .05$). Furthermore, Hoeffler (2003) identified participants' unfamiliarity with the base domain as one of the reasons explaining why an analogy may be ineffective in terms of educating individuals about the benefits of the RNP. Thus, participants were asked to rate how familiar they were with the base domain on a seven-point scale (not familiar at all = 1; very familiar = 7). Respondents were familiar with all the base domains ($mean._{cinema\ projector} = 4.78$; $mean._{cook} = 5.66$; $mean._{secretary} = 5.08$; $p > .05$).

Measure

Product comprehension was measured using six items on a seven-point scale (adapted from Hoeffler, 2003;

Moreau, Lehmann, and Markman, 2001; $\alpha = 0.91$). Participants were asked to what extent they understood how the product worked, thought they would be able to use the product, and understood the main features and the main benefits of the product. They were also asked to what extent they thought the product description was easy to understand, and how straightforward they thought the product was. The scale items used are shown in the Appendix.

Results

The primary objective of this experiment was to test whether delivering information about a RNP using different learning strategies (analogy vs. mental simulation) and different presentation formats (pictures vs. words) influenced the comprehension for the product.

Comprehension was analyzed with a 2 (learning strategy) × 2 (presentation format) analysis of variance (ANOVA). A priori comparisons of means (one-tailed t-tests) were used to follow up on significant effects in the ANOVAs. Mean values for comprehension are given in Table 2. Although no interaction effect was hypothesized, the 2 (learning strategy) × 2 (presentation format) ANOVA yielded a significant strategy × format interaction ($F(1,1147) = 41.7$, $p < .01$, $\eta^2 = 0.035$). Furthermore, there was a significant main effect of the learning strategy (analogy vs. mental simulation) on product comprehension ($F(1,1147) = 45.86$, $p < .01$, $\eta^2 = 0.038$) and of the presentation format (visual vs. verbal) on product comprehension ($F(1,1147) = 137.53$, $p < .01$, $\eta^2 = 0.107$).

Supporting H1a, respondents reported a higher product comprehension when the products were conveyed with a verbal analogy ($\text{mean.}_{\text{verbal analogy}} = 4.67$) than with a visual analogy ($\text{mean.}_{\text{visual analogy}} = 3.17$, $t(542.369) = -12.49$, $p < .01$, $r = 0.47$). An analysis per product revealed that this difference reached significance for all three products: the intelligent oven ($\text{mean.}_{\text{verbal analogy}} = 4.46$ vs. $\text{mean.}_{\text{visual analogy}} = 3.47$, $t(180) = -4.73$, $p < .01$), the video glasses ($\text{mean.}_{\text{verbal analogy}} = 4.41$ vs. $\text{mean.}_{\text{visual analogy}} = 2.96$, $t(193) = -8.025$, $p < .01$), and the Digipen ($\text{mean.}_{\text{verbal analogy}} = 5.15$ vs. $\text{mean.}_{\text{visual analogy}} = 3.09$, $t(176.917) = -9.22$, $p < .01$).

Table 2. Comparison of Means and Standard Deviations[a]

	Visual Mental Simulation		Visual Analogy		Verbal Mental Simulation		Verbal Analogy	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Intelligent Oven	4.04	1.53	3.47	1.49	4.80	1.07	4.46	1.33
Video Glasses	4.41	1.32	2.96	1.31	4.28	1.39	4.41	1.21
Digipen	4.36	1.55	3.09	1.74	5.01	1.09	5.15	1.32
Total	4.27	1.47	3.17	1.51	4.70	1.18	4.67	1.28

[a] Higher means indicate higher product comprehension (scale range 1 to 7). Cell sizes ranged from 84 to 102. SD, standard deviation.

In support of H1b, respondents reported a higher product comprehension when the products were conveyed via a verbal mental simulation ($\text{mean.}_{\text{verbal mental simulation}} = 4.70$) than via a visual mental simulation ($\text{mean.}_{\text{visual mental simulation}} = 4.27$, $t(546.708) = -3.82$, $p < .01$, $r = 0.16$). This difference reached significance for the intelligent oven ($\text{mean.}_{\text{verbal mental simulation}} = 4.80$ vs. $\text{mean.}_{\text{visual mental simulation}} = 4.04$, $t(169.683) = -4.01$, $p < .01$) and the Digipen ($\text{mean.}_{\text{verbal mental simulation}} = 5.01$ vs. $\text{mean.}_{\text{visual mental simulation}} = 4.36$, $t(162.195) = -3.31$, $p < .01$) but not for the video glasses ($\text{mean.}_{\text{verbal mental simulation}} = 4.28$ vs. $\text{mean.}_{\text{visual mental simulation}} = 4.41$, $t(192) = 0.592$, $p = .27$). Interestingly, in the case of the video glasses, the visual mental simulation was actually more effective than the verbal mental simulation.

Contrary to what was predicted in H2a, there was no significant difference in product comprehension between the verbal mental simulation ($\text{mean.}_{\text{verbal mental simulation}} = 4.70$) and verbal analogy ($\text{mean.}_{\text{verbal analogy}} = 4.67$, $t(593) = 0.26$, $p = .403$, $r = 0.01$) conditions. However, some differences can be noted across products. For the intelligent oven the difference reached significance, consistent with the hypothesis ($\text{mean.}_{\text{verbal mental simulation}} = 4.80$ vs. $\text{mean.}_{\text{verbal analogy}} = 4.46$, $t(186.112) = 1.989$, $p = .024 < .05$). The difference did not reach significance for the video glasses ($\text{mean.}_{\text{verbal mental simulation}} = 4.28$ vs. $\text{mean.}_{\text{verbal analogy}} = 4.41$, $t(199) = -0.701$, $p = .242$) and for the Digipen ($\text{mean.}_{\text{verbal mental simulation}} = 5.01$ vs. $\text{mean.}_{\text{verbal analogy}} = 5.15$, $t(195) = -0.817$, $p = .2$).

As predicted in H2b, respondents reported a higher product comprehension when the products were conveyed via a visual mental simulation ($\text{mean.}_{\text{visual mental simulation}} = 4.27$) than via a visual analogy ($\text{mean.}_{\text{visual analogy}} = 3.17$; $t(554) = 8.59$, $p < .01$, $r = 0.34$). This difference reached significance for all three products: the intelligent oven ($\text{mean.}_{\text{visual mental simulation}} = 4.04$ vs. $\text{mean.}_{\text{visual analogy}} = 3.47$, $t(178) = 2.5$, $p < .01$), the video glasses ($\text{mean.}_{\text{visual mental simulation}} = 4.41$ vs. $\text{mean.}_{\text{visual analogy}} = 2.96$, $t(186) = 7.47$, $p < .01$) and the Digipen ($\text{mean.}_{\text{visual mental simulation}} = 4.36$ vs. $\text{mean.}_{\text{visual analogy}} = 3.09$, $t(186) = 5.25$, $p < .01$).

The Role of Visual Attention

One area that may provide insights into the way individuals process information contained in a stimulus is the physiology of reading (Rayner, 1998). Key aspects of this physiology include eye movements (or saccades) and eye fixations (Rayner, 1998). When individuals read, they don't continually scan the lines of text in a smooth manner. Instead, they jump from word to word with a series of brief (200–300 milliseconds) saccades between eye fixations (Rayner, 1998). During each fixation, individuals read the words fixated on before initiating the next saccade. It is during the fixation that visual attention takes place.

The capture of consumers' attention is an increasingly important aim for print advertising (Pieters and Wedel, 2004). As Rayner et al. (2001) pointed out, although a substantial amount of research in experimental psychology has studied the characteristics of eye movements when either reading or looking at pictures (Rayner, 1978, 1998), few studies have addressed the characteristics of eye movements when text and pictures have to be integrated in a comprehension process. This is particularly relevant in the context of print advertising: Advertisements usually consist of a combination of pictorials and words, yet little is known about the extent to which viewers look at the pictures versus the text. Recent findings in experimental psychology using an eye-tracking technique indicate that viewers tend to spend more time looking at the text than at the picture part of print ads (Rayner et al., 2001). This can be explained by the difference in encoding processes for words versus pictures: Individuals can encode much more information per fixation from a picture than from text. Simply said, viewers do not need to spend as much time looking at the pictorial part of the ad as at the text for comprehension.

Eye movements are diagnostic of underlying cognitive processes. For example, eye-movement data can indicate whether a viewer is familiar with a face (Althoff and Cohen, 1999) or whether a student is following an algorithm in solving a mathematical problem (Salvucci, 1999). Furthermore, eye-tracking studies have used a combination of physiological measures and self-reports to explore the relationships between visual attention and brand memory (Pieters, Warlop, and Wedel, 2002; Wedel and Pieters, 2000). However, very little attention has been paid in marketing research to the impact of visual attention patterns on the comprehension of new concepts. Using eye movements to understand learning processes requires the ability to make real-time inferences from eye movements to cognition. As opposed to controlled experiments, which are designed to find out what would happen to eye movements if some cognitive processes were manipulated, eye-tracking experiments help make inverse inferences and discriminate the state of the cognitive processing from observed patterns of eye movements (Feng, 2003). Eye movements are used as an objective and unbiased measure of cognitive processing.

Bottom-up factors are features of the stimuli that determine their perceptual salience (Janiszewski, 1998) and therefore attract attention, such as size and shape. Elements of the stimuli can also be semantically salient and attract attention because they contain essential learning information. One may infer that an increase in attention to elements that contain essential learning information will enhance comprehension. This is likely to hold when the information is conveyed using words, as acquiring information from words is an effortful process, which requires a large number of fixations. However, because individuals do not need to spend as much time to extract information from pictures, they may reach an understanding of the product more rapidly without going through such a large amount of fixations. An increase in attention to the pictorials may actually indicate confusion, as respondents are trying to understand the pictures but cannot achieve this comprehension. It is the combination of eye-movement measures and cognitive (comprehension) measures that will indicate whether an increase in the number of fixations actually reflects comprehension or confusion. Thus,

H3: An increase in visual attention to the advertising elements that were designed to trigger learning using pictures is not likely to lead to an increase in comprehension for (a) mental simulation and (b) analogy.

H4: An increase in visual attention to the advertising elements that were designed to trigger learning using words is likely to lead to an increase in comprehension for (a) mental simulation and (b) analogy.

Study 2

Subjects

Participants were 10 students (four males and six females whose age ranged from 21 to 30) from a British university. The sample size was judged appropriate

for the experiment and was comparable to the sample sizes used in previous eye-tracking studies (Albert et al., 2005; Fleetwood and Byrne, 2006). Participants all had normal uncorrected vision or corrected vision via soft contact lenses.

Stimuli

The stimuli were the same as the ones used in Study 1 for groups 2 and 5. The design is shown in Table 3.

Great care was given to guarantee that the introductory sentence and the product features section had a similar number of words across products. In addition, the number of words allocated to the verbal learning strategies (analogy vs. mental simulation) was similar across products. The size allocated to the visual learning strategies (analogy vs. mental simulation) was also held constant across products.

Method

An infrared corneal reflection eye-tracking system called the ASL was used to display the stimuli and to collect eye-movement recordings (see Muller et al., 1993 for details). This system sampled eye positions every 4 milliseconds, with an average error in determining the location of fixation of less than 0.5 degrees. The system monitored head position remotely to allow participants to view the screen without head restraint. Five participants viewed the two visual conditions, and five viewed the two verbal conditions. Participants were asked to read each ad at their own pace. After each ad, respondents filled in self-report measures. Product comprehension was measured using the same scale used in study 1 ($\alpha = 0.92$).

The ASL instrument measured (1) fixation location and duration; (2) fixation density per ad element (i.e., the total number of fixations for a given area of the stimuli, which conceptually equates to a measure of attention for an area of the ad); and (3) the "scanpath" (Stark, 1994), or pattern of eye fixations, which is the order in which respondents allocated attention to each part of the advert.

Table 3. Design of Study 2

Group	Stimuli 1	Stimuli 2
1	Visual mental simulation Video Glasses ($N = 5$)	Visual analogy Intelligent Oven ($N = 5$)
2	Verbal mental simulation Video Glasses ($N = 5$)	Verbal analogy Intelligent Oven ($N = 5$)

Results

The purpose was to examine whether an increase in fixations to the elements of the adverts that were designed to enhance learning would lead to an increased product comprehension. Using the inverse inference method (Feng, 2003), the combination of eye movements and cognitive measures (i.e., comprehension) should provide insight into whether respondents' attention to the stimuli reflects an enhanced comprehension of the products' benefits or respondents' confusion.

Pearson product–moment correlations were conducted. There was no correlation between the total number of fixations and product comprehension ($r = 0.298$, $n = 20$, $p = .230$). In addition, there was no correlation between total fixation duration and product comprehension ($r = 0.252$, $n = 20$, $p = .314$). There was no correlation between the number of fixations on the elements that intended to stimulate learning in the verbal analogy condition ($r = 0.089$, $n = 5$, $p = 0.911$), the visual analogy condition ($r = -0.768$, $n = 5$, $p = .130$), or the visual mental simulation condition ($r = -0.688$, $n = 5$, $p = .199$) and product comprehension. However, there was a strong, positive correlation between the number of fixations for the element that intended to stimulate learning in the verbal mental simulation condition ($r = 0.993$, $n = 5$, $p = .007$) and comprehension. An increase in attention to the sentence, "Imagine yourself using the E-2000," was associated with higher levels of product comprehension. These findings provide support for H3a, H3b, and H4a. In addition, as the sample size is small, the r coefficients are worthy of further interpretation. Table 4 shows the results of the correlations for each ad.

The results presented in Table 4 indicate that the number of fixations to the learning element of the ad account for 47.33% of the variability in product comprehension in the visual mental simulation condition, 58.98% in the visual analogy condition, 98.6% in the verbal mental simulation condition, and only 0.79% in the verbal analogy condition.

These results show a very strong positive correlation in the verbal mental simulation condition, which suggests that in this condition an increase in the num-

Table 4. Comparison of R Coefficients, R^2 Values, and Variability Percentages

	Visual Mental Simulation	Visual Analogy	Verbal Mental Simulation	Verbal Analogy
R Coefficient	− 0.688	− 0.768	0.993	0.089
R^2	0.473	0.589	0.986	0.007
Variability Percentage	47.33	58.98	98.6	0.79

ber of fixations to the learning element was indicative of an actual increase in attention and ultimately comprehension. In both visual conditions, the strong negative correlations between the number of fixations to the learning element and product comprehension may be explained by the difficulty for some respondents to understand the product presented visually. Respondents who struggled to understand the product description increased their attention to the learning element in an effort to comprehend the product. This suggests that, in the visual conditions, an increase in the number of fixations to the learning element indicated confusion and a lack of comprehension. Finally, in the verbal analogy condition, a significant lack of correlation was observed between attention to the learning element and product comprehension. An explanation may be related to the nature of analogical learning: The analogy between the base and the target may have conveyed only partial information about the product and therefore may have driven respondents to look for essential product information in the rest of the ad.

Discussion

The goal of this paper was to contribute to a better understanding of consumer learning processes in the context of RNPs, with the aim to accelerate product acceptance. The findings show that different types of learning strategies (i.e., analogies vs. mental simulations) can either enhance or undermine the effect of marketing communications on product comprehension, depending on the presentation format (i.e., pictures vs. words) used. Study 1 showed that the use of words in marketing communications for RNPs is generally more effective in enhancing product comprehension than the use of pictorials. However, the video glasses were a notable exception, as the combination of mental simulation and pictures yielded a high comprehension level for this product. This suggests that the use of pictorials may be appropriate to convey information for products of a more hedonic as opposed to utilitarian nature. Study 2 used a combination of physiological measures and self-reports to help elucidate the cognitive processes at work when consumers learn new product information. The results suggest that an increase in attention to an element of the ad can account for one of two underlying processes: (1) enhanced comprehension; or (2) a difficulty to understand product information, which may result in consumer confusion.

Although previous studies have shown that analogies are a valuable means of communicating an RNP's benefits to consumers (Ait el Houssi et al., 2005; Moreau et al., 2001; Roehm et al., 2001), this study's findings also identify mental simulation as a key learning strategy to help consumers understand RNPs. Furthermore, the present study extends previous research on consumer learning for RNPs by examining the impact on product comprehension of presenting product information using pictorials. Findings show that the use of mental simulation conveyed with pictures can enhance product comprehension for hedonic products such as the video glasses. The findings also suggest that analogies should always be conveyed using text, as analogies presented with pictures may hinder consumer learning.

Several unexpected findings deserve closer consideration. First, the verbal mental simulation yielded higher levels of product comprehension than the visual mental simulation for the intelligent oven and the Digipen; however, the difference was not significant for the video glasses, with the visual mental simulation triggering a higher comprehension than its verbal counterpart. This unexpected difference may be due to the nature of the products used in the study: The intelligent oven may be classified as a very utilitarian product, the Digipen as a moderately utilitarian product, and the video glasses as a hedonic product. Using the expectancy value model, several studies investigating utilitarian products (i.e., products that fulfill utilitarian or functional needs) (Babin, Darden, and Griffin, 1994), have demonstrated that objective claims, as opposed to subjective claims, are more credible (Ford, Smith, and Swasy, 1990; Holbrook, 1978) and yield higher purchase intentions (Darley and Smith, 1993). As the use of a verbal description is more explicit than the use of pictorials, it is likely that verbal mental simulation will be superior to visual mental simulation for utilitarian products. In contrast, a hedonic product has the ability to provide

feelings or hedonic pleasure. Research indicates that subjective claims may be more effective than objective claims for hedonic products (Park and Young, 1986). This is consistent with the present study's finding that visual mental simulation generates more positive responses than verbal mental simulation for hedonic products.

In addition, Study 1 shows that the verbal mental simulation and the verbal analogy conditions trigger similar levels of product comprehension for two of the three products, contrary to the proposition that verbal mental simulation would be a superior learning mechanism. This finding shows that both strategies should be envisaged for the design of communications for RNPs. The superiority of the verbal mental simulation over the verbal analogy for the intelligent oven suggests that verbal mental simulations may be particularly appropriate to communicate the benefits of RNPs of a utilitarian nature.

An unpredicted finding was also encountered in Study 2. As expected, an increase in visual attention to the learning stimulus enhanced product comprehension in the verbal mental simulation condition. However, such a correlation was not found in the verbal analogy condition. An explanation may be related to the nature of analogical learning already discussed: The analogy between the base and the target may have conveyed only partial information about the product and therefore may have driven respondents to look for more information in the rest of the ad to grasp the nature of the product. This may explain why an increase in visual attention to this element did not yield enhanced product comprehension.

Theoretical Implications

This study contributes to product innovation and marketing theory in three major ways. Foremost in this study is the finding that alternative learning strategies and presentation formats used in marketing communications for RNPs can have significantly different effects on consumer comprehension of RNPs. This study adds evidence to a growing body of literature (Adaval and Wyer, 1998; Shiv and Huber, 2000; Ziamou, 2002) that demonstrates the power of learning strategies such as mental simulation in preparing consumers for new product acceptance. Consumers' cognitive resources need to be prepared for acceptance of an innovation, in particular for an RNP as consumers significantly lack knowledge about such novel products.

Second, the use of visual stimuli contributes to the debate on the effectiveness of words versus pictures, which are seldom applied in an NPD context. Visualization tools offer the promise of facilitating the processing of new information without overloading the decision maker (Tegarden, 1999) and may lead to a faster understanding of novel information when used in the right conditions. However, the present study demonstrates that visual tools may at times lead to negative outcomes, as some visual ways of conveying information (i.e., visual analogy) may actually accentuate biases in decision making (Lurie and Mason, 2007). One avenue for potential work is to explore the conditions in which visual elements are able to accelerate learning for novel, complex, technological innovations and the conditions in which they may actually hinder learning.

Third, the diverse findings obtained across products in the visual mental simulation condition shed new light on the importance ascribed to the nature of the new product in the choice of a stimuli to enhance learning (Babin et al., 1994). In particular, the context in which the products are used, such as whether the product is used for utilitarian or hedonic purposes, is likely to affect consumers' responses.

Managerial Implications and Directions for Further Research

This research provides valuable information that product managers may want to consider in the development and marketing of RNPs. Visualization tools have the potential to offer managers ways to gain new insights, to make product concepts more accessible (Lurie and Mason, 2007), and to increase comprehension for complex high-tech products. Nonetheless, using a picture of a complex new product is not enough as RNPs possess benefits that might not be apparent from an inspection of a product's surface attributes (Roehm et al., 2001). To enhance product comprehension, visuals that stimulate mental imagery by building a visual scenario of the product in use can be implemented in advertising and concept testing as a surrogate for product demonstration or product trial.

This study's findings also suggest that from a managerial standpoint one needs to be cautious when developing marketing communication strategies for RNPs. Research has shown that consumers system-

atically undervalue innovations whereas firms overvalue their innovation relative to what an objective analysis would suggest (Gourville, 2005). This is consistent with the present study's findings, which show that helping consumers to reach a high level of comprehension for a RNP may prove a daunting task, as comprehension levels may be very low if the strategy used is not appropriate. Appreciation of the challenge faced in conveying the benefits of RNPs to consumers and an understanding of the strategies best suited to the communication of such benefits can help NPD managers in their efforts to bring successful new products to the market.

The findings may also be applied to settings other than advertising, including concept testing, demonstrations, or product design (Durgee, 2003). For example, the use of mental simulations in a demonstration for a RNP may enhance product comprehension and possibly attitudes and intent for the product. In the same manner as Heiman and Muller (1996) identified differences in the optimal length of a demonstration across product categories (e.g., play products, functional products, and time products), differences may exist between hedonic and utilitarian products in terms of the optimal learning strategies marketers use to facilitate consumer product comprehension. Potential adopters may react better to the use of visual scenarios for hedonic products, whereas they may comprehend better the verbal explanations given by a salesperson for products of a more utilitarian nature. Overall, there are significant avenues for research in the context of learning strategies for product demonstrations.

In addition, future research should consider the use of open-ended questions to assess product comprehension in a more objective manner. This will provide additional insights into the nature of consumers' product knowledge postexposure to advertising for an RNP and will pinpoint any misconceptions about the nature of the product.

Finally, more research is needed to examine the effects of alternative learning strategies and presentation formats on additional outcome constructs, including attitudes and behavioral intent. Previous research has focused on the role of visuals as persuasion tools in advertising, which suggests that visually dominant ads for RNPs are likely to enhance product attitudes and behavioral intentions. If future research shows that learning strategies conveyed visually have the potential to both enhance product comprehension and attitudinal responses, then marketers could consider the use of pictures stimulating mental imagery as a potential avenue for future communication strategies.

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Appendix. Scale Items for Product Comprehension

I found the product description:

1. Difficult to understand—Easy to understand
2. Confusing—Straightforward

Items for which 1 = strongly disagree; 7 = strongly agree.

Please indicate the extent to which you agree with the following statements:

3. After reading the advertisement, I have a very strong understanding of how this product works.
4. After reading the advertisement, I would be able to use the product.
5. After reading the advertisement, I understand what the main features of this product are.
6. After reading the advertisement, I understand what the main benefits of this product are.