

Design for better comprehension

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DOI

[10.7945/C2X38T](https://doi.org/10.7945/C2X38T)

Publication date

2017

Document Version

Final published version

Published in

Proceedings of the IASDR Conference RE: Research

Citation (APA)

Peiyao, C., Mugge, R., & de Bont, C. (2017). Design for better comprehension: Design opportunities for facilitating consumers' comprehension of really new products (RNPs). In C. Vogel, & G. Muratovski (Eds.), *Proceedings of the IASDR Conference RE: Research* (pp. 1-33). IASDR. <https://doi.org/10.7945/C2X38T>

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Design for Better Comprehension: Design opportunities for facilitating consumers' comprehension of really new products (RNPs)

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Abstract

Developing successful RNPs can bring competitive advantages for companies. However, the success rate of RNPs are relatively low because consumers often feel resistant to adopt them. One reason for consumers' resistance is their lack of comprehension of RNPs. To facilitate consumers' comprehension, this paper conceptually discusses the opportunities related to designing the appearances of RNPs. More specifically, to facilitate consumers' internal and external learning, this paper explores four underlying mechanisms: 1) product appearance as a visual cue to trigger category-based knowledge transfer, 2) to trigger analogy-based knowledge transfer, 3) product appearance as an information carrier to communicate innovative functionality directly, and 4) product appearance as a way to trigger congruity with innovative functionality of RNPs. The rationales for each underlying mechanism are conceptually discussed, supported with relevant empirical evidence and examples found in the markets.

Keywords

Consumers' comprehension, consumers' internal learning, consumers' external learning, really new products (RNPs), product appearance.

Designers are frequently involved in developing really new products (RNPs), which can gain competitive advantages for companies (Dougherty, 1992). RNPs (a.k.a. discontinuous or radical innovations) refer to new products that integrate advanced technology that has rarely been used in the industry before and enables consumers to do things they were previously unable to do (Garcia & Calantone, 2002; Song & Montoya-Weiss, 1998). For example, a smart home system is a RNP that connects a network of sensors and an information terminal to collect immediate information at home. Through an app on a smart phone, consumers can monitor and control situations at home distantly, which consumers could never do before. In contrast to RNPs, incrementally new products (INPs) integrate current technologies. INPs (a.k.a. discontinuous or radical innovations) provide new benefits, features, or improvements on existing products. For instance, the launch of the first iPhone was considered a RNP, while the later versions (e.g., iPhone 6) are considered INPs because they provide incrementally functional improvements based on previous versions.

Although successful RNPs can provide companies with competitive advantages, the success rate of RNPs is relatively low (Cooper & Kleinschmidt, 1987) The success of RNPs ultimately depends on consumers' adoption of RNPs (Hauser, Tellis, & Griffin, 2006). However, consumers often feel resistant to adopt RNPs (Ram & Sheth, 1989). One of the reasons for consumers' resistance is consumers' lack of comprehension. Different from INPs that consumers can understand relatively easily based on accumulated knowledge and experience, gaining comprehension of RNPs is difficult

for consumers (Hoeffler, 2003). They may not understand how RNPs work and what benefits RNPs can provide (Hoeffler & Herzenstein, 2011) because the knowledge that is needed to understand the new technology goes beyond consumers' current knowledge (Gatignon & Robertson, 1985) and the integration of really new technology also calls for completely different ways of thinking and new usage patterns (Veryzer, 1998).

Consumers' comprehension of RNPs

Gaining comprehension of RNPs is important because it is a precondition for consumers' further evaluation and adoption of RNPs (Reinders, Frambach, & Schoormans, 2010; Veryzer, 1998). Based on consumers' adoption process, it is suggested that consumers go through five stages to adopt a RNP (Rogers, 1995), as outlined in figure 1. In the first stage, the knowledge stage, consumers become aware of a RNP and have some initial ideas of how it functions. As consumers may not have any experiences with the RNP up to that point, the comprehension obtained at this stage is predominantly a subjective comprehension of the RNP. Consumers may feel that they lack comprehension of the RNP and its innovative functions, resulting in a feeling of discomfort and confusion. They may also feel confident that they understand the RNP and its benefits. After the knowledge stage, the persuasive stage starts, in which consumers form a favorable or unfavorable attitude. Next, at the adoption stage, consumers engage in activities that lead to a choice to adopt or reject the RNP. The implementation and confirmation stage follows, where consumers use

and evaluate the RNP. According to this framework, consumers are supposed to carefully learn and consider the potentials of RNP during the persuasive and decision stages, and make an adoption or rejection decision afterwards. The resistance to a RNP results from a serious and careful consideration and evaluation of a RNP. However, recent research has pointed out that consumers' resistance to RNPs does not, in fact, involve a serious evaluation of the RNP (Talke & Heidenreich, 2014). In most cases, consumers' initial resistance towards a RNP is established early in the knowledge stage. If consumers feel that they lack comprehension of a RNP, the resulting confusion can result in initial resistance to the RNP. This resistance then stimulates these consumers to disregard its potential and subsequently reject it. Therefore, it is crucial to ensure that consumers comprehend RNPs at the knowledge stage.

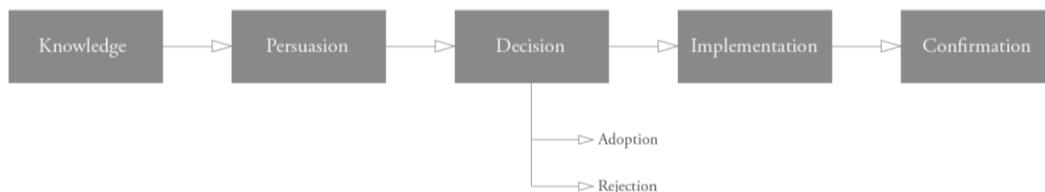


Figure 1. The innovation-decision process (Rogers, 1995)

To facilitate consumers' comprehension of RNPs, several effective marketing strategies have been developed in marketing research. Consumers' comprehension of RNPs can be facilitated through internal and external learning (see figure 2). Consumers can learn RNPs through making use of the internal stored knowledge, which is termed as consumers' internal learning. Specifically, it is possible to facilitate

consumers' internal learning through transferring internal knowledge from a familiar domain to a RNP, such as the usage of categorization (Moreau, Markman, & Lehmann, 2001), analogical learning strategy in advertisements (Gregan-Paxton, 2001; Gregan-Paxton & John, 1997), and product bundling (Reinders et al., 2010). Consumers can also learn RNPs from external sources, such as advertisements, websites, other consumers, product demonstrations and direct experience with the RNP. Learning from external sources is defined as consumers' external learning (Hoeffler & Herzstein, 2011). It is possible to facilitate consumers' external learning by mental stimulation (Dahl & Hoeffler, 2004; Hoeffler, 2003) and exposing consumers to RNPs and demonstrations of RNPs (Hoeffler & Herzstein, 2011). In addition, product appearance may influence how consumers respond to RNPs (Mugge & Dahl, 2013). Product appearance can serve as a visual cue for consumers' categorization of a RNP (Rindova & Petkova, 2007). By looking at a product appearance, consumers can identify which category the product belongs to, which could further trigger category-based or analogy-based knowledge transfer, leading to enhanced consumers' comprehension. Moreover, product appearance can directly communicate the innovative technology of a RNP through visualizing the innovative technology (Eisenman, 2013). For example, Dyson vacuum cleaner adopts the innovative dual-cyclone technology which requires multiple cyclones to produce airflow. The product appearance exposes these cyclones rather than hiding them, aiming to communicate how the innovative technology works. However, designing product appearances to facilitate consumers' comprehension only received limited research

attention so far, even though product appearance also carries the potential to facilitating consumers' internal and external learning of RNPs (Cheng & Mugge, 2015, 2016; Mugge & Dahl, 2013). To fill in this gap, this paper aims to conceptually explore the potentials of product appearance for influencing consumers' comprehension of RNPs.

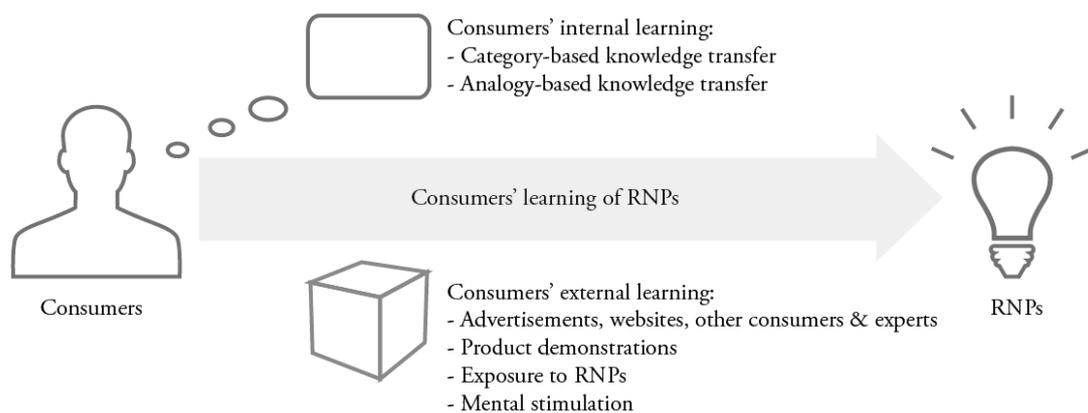


Figure 2. Current marketing strategies for facilitating consumers' learning of RNPs.

Consumer responses to product appearance

The value of designing product appearances has been well acknowledged. Product appearance can contribute to companies' financial performances (Candi, 2010; Hertenstein, Platt, & Veryzer, 2005), facilitate brand recognition (Person & Snelders, 2010), influence investors' behaviors in the stock market (Aspara, 2012), and elicit a variety of consumer responses (Bloch, 1995). By seeing a product appearance, consumers can process it cognitively, generate emotional responses towards it, and form behavioral responses by triggering a tendency to either approach or avoid the product (Bloch, 1995; Crilly, Moultrie, & Clarkson, 2004). While processing a

product appearance cognitively, consumers can form aesthetic impressions and gain symbolic associations. In addition, consumers can draw some inferences concerning the product, also termed as product beliefs (Bloch, 1995), such as to which product category a product belongs to, what a product does, how effective a product performs, and how to operate it (Creusen & Schoormans, 2005).

Furthermore, previous studies have pointed out that product appearance plays different roles along the different stages in a product life cycle (Eisenman, 2013; Person, Schoormans, Snelders, & Karjalainen, 2008). In the product maturity stage where products are difficult to differentiate from each other in terms of functionality, product appearance can be used to differentiate from competitors in the cluttered market. For example, in the automobile industry, similar to introducing innovative technology, designing novel appearances can also stimulate the sale volumes (Talke, Salomo, Wieringa, & Lutz, 2009). Differently, in the early stage of the product life cycle where markets have little understanding of the radical technology, the prominent role of product appearance is to communicate the innovative technology (Eisenman, 2013; Rindova & Petkova, 2007; Simoni, Cautela, & Zurlo, 2014). As suggested in prior, while embodying RNPs, companies can design the appearances of RNPs to explain what the RNP does, explain the complex innovative technologies within the RNP, and how the RNP should be used, in order to facilitate consumers' comprehension of the RNP (Eisenman, 2013).

Although the conceptual importance of using product appearances to communicate

innovative technology of RNP has been highlighted in previous studies (Eisenman, 2013; Rindova & Petkova, 2007; Simoni et al., 2014), in the design research area, only limited research attention has been paid to investigating it to provide practical guidelines for designers. Thus far, only several empirical studies have been conducted to examine how different appearance attributes (i.e., typicality, visual complexity, and transparency) influence consumers' processing of RNPs (Cheng & Mugge, 2015, 2016; Mugge & Dahl, 2013). However, it is important to explore the possibilities of designing product appearances to influence consumers' comprehension of RNPs because designers are responsible for embodying RNPs and designers have the intention to assist consumers in comprehending a product through its appearance (Crilly, Moultrie, & Clarkson, 2009). More importantly, for many RNPs, the integrated technology in the RNPs does not fundamentally influence the product appearances or only to a certain extent, and thus product appearances are not completely predefined by or dependent on the integrated technology (Rindova & Petkova, 2007). Then, designers have the freedom to embody product innovations in different product appearances and thereby deliberately facilitate consumers' learning. For example, when the first e-book readers were launched into the market, the technology allowed the product to be designed in any shape. Nevertheless, the product was designed to resemble a physical book to help consumers understand that e-book readers are used for reading (Hekkert & Cila, 2015). Therefore, it is both necessary and urgent to equip designers with the knowledge on how to embody RNPs to influence consumers' comprehension.

This paper aims to conceptually discuss the possible opportunities for designing product appearances to influence consumers' comprehension of RNPs. Based on current marketing strategies for facilitating consumers' internal and external learning, we discuss how product appearances of RNPs can influence both learning strategies (see figure 3). Specifically, product appearances of RNPs can serve as a visual cue to trigger consumers' internal learning through category-based and analogy-based knowledge transfer. To facilitate consumers' external learning, product appearances of RNPs can serve as an information carrier to communicate the innovative technology of RNPs. Product appearances of RNPs can also be used as a way to indicate the innovative functionality of RNPs by triggering a congruity between product appearance and functionality, which further influences consumers' learning process of RNPs. These four kinds of design opportunities are discussed in the next sections. The underlying mechanisms for design opportunities are discussed firstly, supported by empirical evidence and corresponding examples.

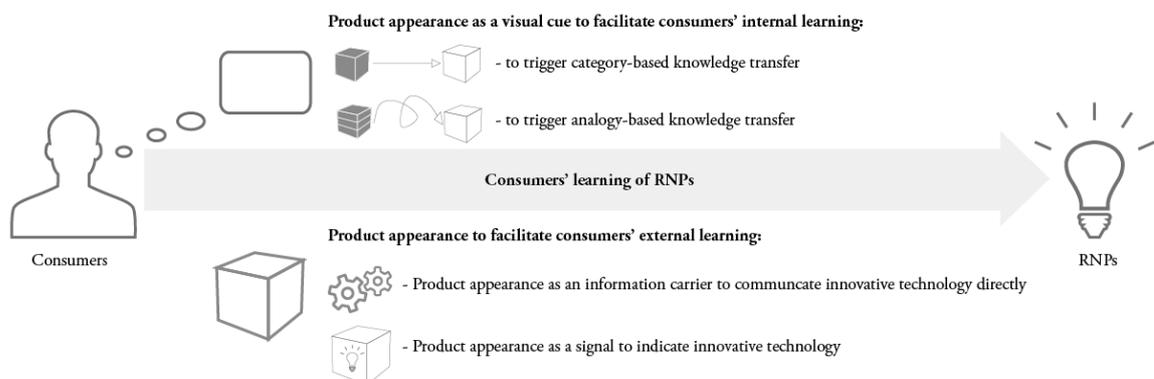


Figure 3. The potential of product appearances for facilitating consumers' internal and external learning of RNPs.

Designing product appearances to facilitate consumers' internal learning

One of the barriers for consumers' comprehending RNPs is the lack of knowledge (Gatignon & Robertson, 1985). RNPs are truly new, and thus there is no available knowledge stored in consumers' memory that is ready for explaining RNPs. However, it is possible to make use of consumers' stored knowledge related to other products and objects to facilitate consumers' learning of RNPs. Previous research demonstrated that category-based knowledge transfer and analogy-based knowledge transfer are effective to help consumers' learning of RNPs.

Product appearance as a visual cue to trigger category-based knowledge transfer

By definition, one of the characteristics of RNPs is the uncertainty to be categorized the innovation as a member of a specific product category (Lehmann, 1994). Because a RNP often provides highly innovative functionality, the conceptual distance between the RNP and existing product categories is large, due to which the RNP cannot be readily assigned to an existing product category. However, the large conceptual distance between a RNP and existing product categories actually gives managers the freedom to choose the positioning of the RNP (Hoeffler & Herzstein, 2011). Managers can position the RNP as belonging to an existing product category, aiming to activate consumers' category-based knowledge transfer. For example, when the smartphone was launched, it could be categorized into the product category of a

cellphone because it provided the same function for making phone calls as cellphones did. However, it could also be categorized into the product category of computers because it integrates computer operating system. The smartphone was still labeled as a cellphone, aiming to help consumers transfer the knowledge from the cellphone category to the RNP.

To trigger category-based knowledge transfer, previous studies concluded that it is necessary to provide category cues for consumers (Gregan-Paxton, Hibbard, Brunel, & Azar, 2002). In terms of different category cues, previous studies have demonstrated that consumers are more influenced by visual cues than conceptual cues (Gregan-Paxton, Hoeffler, & Zhao, 2005). For example, for a smartphone, when presenting consumers a picture of a cellphone (visual cue) but labelling it as a computer (conceptual cue), consumers tend to perceive it as a cellphone, because the conceptual cue informs what the product does while visual cue defines what the product is (Barton & Komatsu, 1989).

In line with above, product appearance can serve as a visual cue for consumers' categorization of a RNP. After carefully deciding the position of the RNP, designers can design product appearance to resemble the product prototype in this product category. For example, the first smart phone resembles a traditional cellphone (see figure 4). Typicality of the product appearance determines the ease of consumers' categorization (Creusen & Schoormans, 2005). Previous studies have also empirically

demonstrated that a typical-looking RNP can be categorized with more certainty (Goode, Dahl, & Moreau, 2013) and fewer learning costs (Mugge & Dahl, 2013), which could further lead to enhanced consumers' comprehension. Thus, when seeing the RNP, consumers can recognize the RNP as a member of the product category. Subsequently, the category-based knowledge transfer process is activated. Consumers can make use of the knowledge from this product category to learn about the RNP, leading to enhanced consumers' comprehension.



Figure 4. Picture of the first smart phone: IBM Simon launched in 1994 vs. picture of a typical cell phone at that time: Motorola 8900X2, launched in 1994

Labelling a RNP as a member of an existing product category indicates a match between the RNP and the product category (Gregan-Paxton & Moreau, 2003). Such category-based knowledge transfer encourages an extensive knowledge transfer from the product category to the RNP, which maximizes within-category similarity while reduce similarities across categories (Medin & Schaeffer, 1978; Rosch & Mervis, 1975). As a result, within a RNP, consumers may gain good comprehension towards the parts that shared similarities with the product category. However, for the

innovative features of the RNP that differ from the existing product category, consumers may not comprehend very well. For instance, in the example of smartphone, consumers may understand this smartphone is used for making phone calls, but consumers may encounter difficulties while comprehending other functions, such as providing different applications, making pictures, etc.

Product appearance as a visual cue to trigger analogy-based knowledge transfer

In addition to labeling RNPs as a member of a particular product category, marketers can consider establishing a totally new product category for RNPs (Hoeffler & Herzstein, 2011). The introduction of a smart home system is such an example, which was not assigned into any existing product category but established a new one. In this case, although no available knowledge can be transferred from an existing product category, it is still possible to help consumers learn these RNPs through analogical learning: by relating the RNP to a familiar product or concept, termed as a source (Gregan-Paxton & John, 1997). The RNP does not need to be closely related to the source. Instead, a strong similarity shared by the RNP and the source can make a sound analogy. For example, a smart home system was introduced to the markets with the analogy of “mother” (see figure 5). A smart home system does not relate to a mother at first glance. But the functions of a smart home system that collects all the information around home can be comparable to the role of a mother at home who often knows everything surrounding home.



Figure 5. The smart home system: “Mother”

Analogy-based knowledge transfer refers to knowledge transfer from an independent source (e.g., a mother) to the target domain (e.g., a smart home system) (Gregan-Paxton & John, 1997). It contains three steps: 1) identification of the source domain, 2) mapping the source domain to the target, and 3) transferring the knowledge from the source domain to the target. Prior research has demonstrated that when describing a RNP with an analogy in an advertisement, consumers’ comprehension of RNPs will increase because consumers can identify the source, build the association between the source and the target, and transfer important characteristics from the source to the target (Houssi, Morel, & Hultink, 2009).

To facilitate consumers’ learning through analogy, designers can consider designing appearances of RNPs to resemble a source product or concept, in order to trigger consumers’ recognition of the relationship between a RNP and a source. Product

metaphor is such a specific way to design a product appearance that “intentionally reference the physical properties of another entity” (Hekkert & Cila, 2015). A product metaphor relates a source and a target product physically and conceptually. On the physical level, the product resembles the shapes of the source. On the conceptual level, the product and the source are associated in terms of certain meanings (Forceville, Hekkert, & Tan, 2006; Hekkert & Cila, 2015; Van Rompay, 2008).

When a product metaphor is used to embody a RNP, these two levels of associations make the product metaphor promising to facilitate analogy-based knowledge transfer for consumers’ learning of the RNP. On the one hand, the physical similarities can help consumers to identify the source domain (Forbus, Gentner, & Rattermann, 1993). On the other hand, within a product metaphor, the conceptual association between a RNP and a source is already integrated, which becomes a basis for analogical learning. For example, “Mother” is a smart home system that is embodied in the product metaphor of a mother (see figure 6). On the physical level, the design of “Mother” resembles the shape of a doll, which attempts to remind consumers thinking of the role of a mother at home. On the conceptual level, the association is built between the smart home system that collects all the information surrounding the home and a mother who often knows everything at home. As a result, consumers can gain better comprehension of the smart home system.

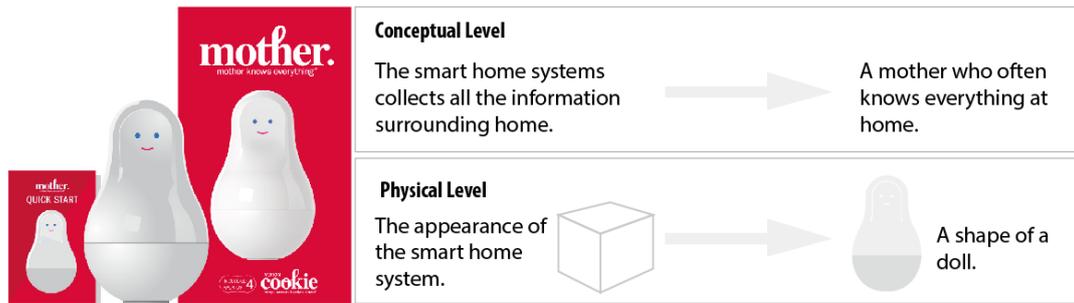


Figure 6. Two levels of product metaphors

When using product metaphors in RNPs, designers firstly need to carefully select sources probably by working together with marketers. This source should share important similarities with the target RNPs. Next, designers need to make sure the source is well integrated into the product metaphors. As visual metaphors often carry the risk of multiple interpretations (Van Rompay & Veltkamp, 2014), it is crucial for designers to ensure that the product metaphor they designed only directs to the selected source domains. In the example of “Mother,” consumers may link the product design to multiple sources, such as a Russian matroesjka, a cartoon character of Barbamama, and/or the role of a mother at home. This ambiguity could hinder the further knowledge mapping and transfer, resulting in reduced consumers’ comprehension.

Different from category-based knowledge transfer that encourages extensive knowledge transfer from the existing product category, analogy-based knowledge transfer facilitates only a subset knowledge transfer from the source category (Gregan-paxton & Moreau, 2003). In the example of smart home system “mother,”

within the role of a mother at home, only the characteristic of knowing situation at home is transferred to the smart home system. Other characteristics are not transferred, such as taking care of every family member. This specific transfer can help consumers comprehend the innovative benefits of a RNP. However, the success transfer of the knowledge also depends on consumers' ability of recognizing similarities and mapping the corresponding knowledge into a RNP. Consumers may encounter difficulties in identifying the similarities between a source and a RNP (Gick & Holyoak, 1983). In this case, the presence of a clarification that states the similarities between a source and a RNP can be helpful.

Designing product appearances to facilitate consumers' external learning

In addition to stimulate consumers' internal learning through making use of stored knowledge, marketers can facilitate consumers' external learning of RNPs. Consumers are exposed to different external sources, including advertisements, product demonstrations and RNPs themselves. Therefore, appearance of RNPs can serve as a source for facilitating consumers' external learning. Specifically, product appearances can facilitate consumers' external learning through directly communicating innovative technology integrated in RNPs and influencing the congruity between product appearance and innovative functionality of RNPs.

Product appearance as an information carrier to communicate innovative

technology directly

Because RNPs often integrate highly innovative technology, consumers may not understand how they function (Hoeffler & Herzstein, 2011). Product appearances can visually communicate the innovative technology and thereby help consumers understand how RNPs work. For example, different from the common technology of capturing dust by differences in pressures, the handheld vacuum cleaner from Dyson adopts the innovative dual-cyclone technology (see figure 7a), which allows it to provide continuously suction power. To produce airflow and capture dust, this innovative technology requires 15 cyclones that are arranged across two levels on the top of the vacuum cleaner. Rather than hiding these cyclones, this handheld vacuum cleaner directly exposes them and highlights outlines of them with a red line. , whose outlines of each cyclone are highlighted with a red line. This unique design can help consumers notice the innovativeness of the adopted technology and learn that this innovative technology is different from the ones they already know. Moreover, in combination with illustrations in the advertisement (see figure 7b), this design can directly communicate the innovative technology: how air flows are generated in each cyclone and how these air flows come together to provide suction power. In this way, consumers can gain a subjective comprehension of how this innovative technology works, and they can become more convinced of the benefits of the innovative technology.



Figure 7a.



Figure 7b.

Figure 7a. Dyson handheld vacuum cleaner.

Figure 7b. Snapshot of an explanation of the technology.

Visualization is an effective tool to help people learn (e.g., flowchart, illustration). Designers can visualize how complex innovative technology works while designing product appearance, to simulate consumers' learning of the innovative technology, which could lead to an enhanced consumers' comprehension. Different from strategies to facilitate consumers' internal learning, using such visualizations to facilitate consumers' learning does not rely on consumers' current knowledge storage. However, comprehending the innovative technology based on the visualization may require consumers' imagination. According to the description of the innovative technology, consumers need to imagine how it works based on the visual clues on the product appearance. Sometimes, it can be difficult for consumers. Thus, certain aids can help consumers' imagine of the innovative technology (e.g., the line drawing in figure 7b).

Product appearance to trigger congruity with the RNP's functionality

Consumers tend to use product appearance to infer product functionality (Bloch, 1995;

Creusen & Schoormans, 2005; Crilly et al., 2004). Previous studies demonstrated that when seeing a novel product appearance, consumers tend to infer that the product integrates innovative technology (Mugge & Schoormans, 2012a, 2012b). When the product indeed integrates innovative technology, a congruity is triggered. In contrast, when the product adopts plain technology, incongruity is evoked. Such (in)congruity makes significant influences on consumers' processing of product. Specifically, while processing a product, consumers have to process information conveyed through product appearance and the product function information. The (in)congruity influence the processing fluency of consumers' processing. The congruity can bring a fluent processing, resulting in more positive attitudes (Reber, Schwarz, & Winkielman, 2004). In contrast, incongruity evokes a disfluent processing, which requires ample cognitive resources, resulting in reduced consumers' evaluation (Van Rompay, Pruyn, & Tieke, 2009; Van Rompay & Pruyn, 2011).

Following this notion, congruity between product appearance and functions can bring a fluent consumers' processing of RNP, leading to consumers' enhanced comprehension (Cheng & Mugge, 2015). Specifically, when seeing a visually complex RNP, consumers expect complex technologies adopted in the RNP. For example, a visually complex appearance can signal the innovative functionality of a product (Norman, 1988) and designing visually complex appearance is often used in products that are targeted to professional consumers, such as the professional mouse in figure 8. In fact, complexity is one of the characteristics of an innovation (Rogers,

1995). Thus, a congruity is triggered between a complex appearance and innovative functionality of a RNP.



Figure 8. Picture of professional mouse

Designers can design appearance of RNPs to trigger congruity with innovative functionality of RNPs. Such congruity can influence the fluency of consumers' learning process, which further influence consumers' comprehension. Moreover, triggering such congruity does not require consumers' stored knowledge or ability, which give designers more freedom to design. While designing, designers can consider manipulating certain appearance attributes to trigger congruity between product appearance and the innovative functionality of RNPs. Thus far, novelty and visual complexity have been demonstrated to be congruent with the innovative functionality of RNPs. Additional appearance attributes could exist as well, such as the curviness of the outline of products, materials of product appearances, and certain product personality. For example, the innovative hair dryer from Dyson (see figure 9) integrates the air multiplier technology to provide powerful and stable airflow, sensors

to measure the temperature of the hair and microprocessor to give suggestions of the optimal temperature. It allows a fast hair drying tasks without damaging the hair. The product design uses a geometric appearance and metallic surfaces, to convey a high-tech feeling, which together creates an expectation of a highly innovative functionality provided by the product.



Figure 9. Picture of Dyson hair dryer

General Discussion

To facilitate consumers' comprehension of RNPs, current research mainly focused on developing communication strategies in marketing areas. Limited research attentions have been paid on facilitating consumers' comprehension through designing appearances of RNPs. This paper fills in this gap by conceptually discussing the designing opportunities for facilitating consumers' learning through embodying RNPs. More specifically, based on the roles of product appearance for influencing consumer responses (Creusen & Schoormans, 2005; Crilly et al., 2004; Noble & Kumar, 2010),

this paper explores four underlying mechanisms through which product appearance can facilitate consumers' internal and external learning of RNPs.

To facilitate consumers' internal learning, designers can try to design appearances of RNPs to resemble the prototype from a certain product category. However, a typical looking might make the RNP look the same as other products on the market, which may make consumers wonder about the innovativeness of the RNPs. In this case, the appearance should be looked typical to trigger the category-based or analogy-based knowledge transfer, but also look slightly different from other products, in order to persuade consumers the innovativeness of the RNP. While designing, designers need to carefully consider this balance.

Furthermore, to facilitate consumers' external learning, designers can design appearances to communicate the innovative technology directly. When discussing the relationships between product appearance and product functionality, previous studies have focused on the indications that product appearance visually suggest in terms of how to use/operate the product, such as the four semantic functions of a product appearance (i.e., description of a product's purpose, expression of product qualities, exhortation of requires from a product, identification of product category) (Mono, 1997), and visual clues that should be provided by a product appearance (i.e., affordances that allow certain actions to operate a product, constraints that limit certain actions to prevent improper operation, correspondences between what a

consumers' actions and a product's visual clues) (Norman, 1988). A research gap exists in designing product appearance to facilitate consumers' learning of innovative functionality, not merely how to operate a product. This paper fills in this gap by proposing that product appearance can fulfill this goal. However, more research needs to be conducted to empirically examine whether and to what degree the presence of information carried through product appearances can improve consumers' comprehension of RNPs. Furthermore, a certain optimal amount of visual clues may exist. For example, the full exposure of product internal components can confuse or even terrify consumers, because it is often filled with digital chips. In contrast, the mere presence of several lines to indicate the innovative functionality seem not sufficiently convincing for consumers. Future research opportunities lie in exploring the optimal balance.

While designing RNPs, designers need to choose to use which underlying mechanisms to facilitate consumers' learning. Each underlying mechanism has its potentials and risks. The decision can be influenced by multiple factors, such as the marketing strategy for the RNP. Moreover, although each underlying mechanism is distinct from each other, designers can combine them to facilitate consumers' comprehension. For example, designers can design product appearance of RNPs to facilitate category-based knowledge transfer and communicate innovative technology at the same time. Designers can design a product appearance that is typical for the product category to stimulate consumers' categorization. Meanwhile, designers can

still highlight the innovative parts to communicate the innovative technology.

Although the presented design opportunities can be theoretically justified and are supported with some empirical evidence and product examples on the markets, it is important for future research to investigate the optimal situations where product appearance will have the most effective influence on consumers' comprehension. Certain moderators may exist to influence the effectiveness of the proposed design opportunities. For example, to trigger consumers' analogy-based knowledge transfer, designers can design product metaphors to embody RNPs. However, visual metaphors, including product metaphors, often carry the risks of allowing multiple interpretations. Thus, to prevent this risk, the presence of a textual clue that states the source of the product metaphor can be helpful (Rompay & Veltkamp, 2014). Therefore, future research needs to explore the optimal situations that ensure the effectiveness of the proposed possibilities.

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