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Publication date

2017

Document Version

Final published version

Published in

Conference Proceedings of the Design Management Academy

Citation (APA)

Peiyao, C., Mugge, R., & de Bont, C. (2017). A smart home system is like a " Mother"! The effects of product metaphor on consumers' comprehension of really new products (RNPs). In E. Bohemia, C. de Bont, & L. Svengren Holm (Eds.), *Conference Proceedings of the Design Management Academy : Research Perspectives on Creative Intersections* (pp. 1079-1094). (Conference Proceedings of the Design Management Academy; Vol. 1). The Design Research Society.

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A smart home system is like a “Mother”! --- The effects of product metaphor on consumers’ comprehension of really new products (RNPs)

CHENG Peiyao^a; MUGGE Ruth^b and DE BONT Cees^a

^a School of Design, Hong Kong Polytechnic University

^b Department of Product Innovation Management, Faculty of Industrial Design Engineering, Delft University of Technology.

* Corresponding author e-mail: pei-yao.cheng@connect.polyu.hk

doi: 47

Really new products (RNPs) are often difficult to comprehend, which may hinder consumers’ adoption. It is generally believed that designers can stimulate consumers’ comprehension by embodying RNPs in the form of product metaphors. However, empirical evidence for this is lacking. This study empirically examines the effects of product metaphors on consumers’ comprehension of RNPs. The findings of an experiment (N= 114) demonstrated an interaction effect of the presence of a product metaphor and a textual clue that explains the product metaphor on consumers’ comprehension of RNPs. Specifically, embodying a RNP in the form of a product metaphor will confuse consumers and reduce comprehension, unless the product metaphor is also explained through a textual clue.

Keywords: consumers’ comprehension, really new products (RNPs), innovations, product metaphor.

Introduction

Designers are often involved in developing really new products (RNPs). RNPs (a.k.a. discontinuous or radical innovations) refer to new products that integrate highly advanced technology that has been rarely used in the industry before. Different from incrementally new products (INPs) that provide better product performance based on current products, RNPs provide consumers with highly innovative functions that allow consumers to do things that they could never do before (Garcia & Calantone, 2002). An example of a RNP is



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“SmartThings” of Samsung, which is a smart home system (see figure 1). The smart home system contains a hub and multiple smart devices that are connected to it. The smart devices collect various information about the home, such as energy consumption, the presence of family members, door locks, and entry movement that people can access through an app, allowing them to monitor and control their home from a distance.



Figure 1. “SmartThings” of Samsung (source: <https://www.smarthings.com/>)

Although RNPs can offer significant benefits, consumers often do not readily adopt them (Ram & Sheth, 1989) because consumer experience difficulty understanding the innovative functions provided by RNPs (Hoeffler, 2003). RNPs integrate advanced technologies that are totally different from current technologies used in products on the markets, due to which comprehending RNPs requires a shift in consumers’ thinking patterns (Veryzer, 1998). The previously accumulated knowledge and experience are not effective for explaining RNPs because understanding RNPs require completely new knowledge (Gatignon & Robertson, 1985). As a result, consumer often encounter difficulty comprehending RNPs, which is one of the main barriers for the success of RNPs (Hauser, Tellis, & Griffin, 2006).

To stimulate consumers’ comprehension of RNPs, current research explores several marketing strategies, such as analogical learning (Gregan-Paxton, Hibbard, Brunel, & Azar, 2002) and product bundling (Reinders, Frambach, & Schoormans, 2010). These strategies aim to relate a RNP with another product that consumers are familiar with. Thus, consumers can learn the RNP through making use of the knowledge of the familiar product, which lead to enhanced comprehension. Although product appearance has been demonstrated to influence consumer responses to RNPs (Cheng & Mugge, 2015, 2016; Mugge & Dahl, 2013), the potential of designing product appearances to facilitate consumers’ comprehension of RNPs is largely overlooked. In fact, relating a RNP to a familiar product can also be achieved through product design. Specifically, using product metaphors is a common practice that designers use to stimulate consumers to relate a RNP to a familiar product (Hekkert & Cila, 2015). For example, similar to “SmartThings” (see figure 1), “Mother” is a smart home system that is embodied in the product metaphor of a mother (see figure 2). It is expected that consumers can relate the benefits of the smart home system to the role of a mother at home, resulting in better comprehension of the smart home system.



Figure 2. The smart home system: “Mother” (source: <https://sen.se/mother/>)

Although product metaphors hold great potential to facilitate consumers’ comprehension of RNPs, current studies have not yet empirically investigated the effects of product metaphors. As designers and design managers are responsible for deciding whether and/or how to use product metaphors to embody RNPs, it is important to equip them with the knowledge of how to make better use of product metaphors to influence consumers’ comprehension of RNPs. This study aims to fill in this gap.

Product Metaphors

Product metaphor is a specific kind of metaphor. A metaphor is defined as “understanding and experiencing one kind of thing in terms of another” (p.5) (Lakoff & Johnson, 1980). A metaphor relates two entities: target and source. Based on the shared similarities, the properties of a source are selected and assigned to a target, to express certain characteristics of the target. Following this, product metaphors are defined as product appearances that “intentionally reference the physical properties of another entity for specific, expressive purposes” (Hekkert & Cila, 2015). A product metaphor entails conceptual and physical associations between the source and the product. On the conceptual level, the product and the source are associated in terms of certain meanings. On the physical level, the product resembles the shapes of the source (Forceville, Hekkert, & Tan, 2006; Hekkert & Cila, 2015; Van Rompay, 2008). As shown in figure 3, the smart home system “Mother” can be used to explain these two levels. On the conceptual level, a conceptual 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. In this way, the benefits of the smart home system are related to the role of a mother at home. Furthermore, a product metaphor not only builds a conceptual association, but also translates such a conceptual association physically in the product appearance. In addition to the conceptual association, the design of “Mother” resembles the shape of a doll.

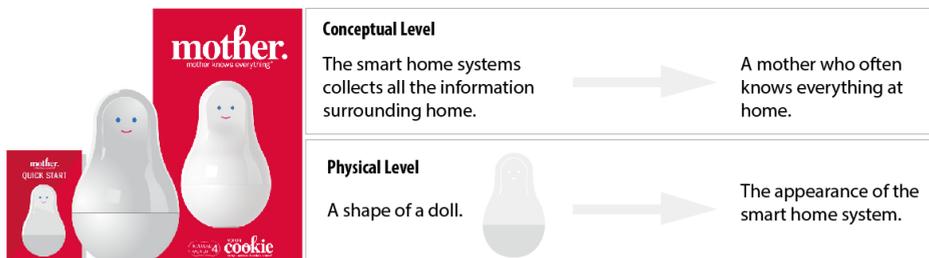


Figure 3. Two levels of product metaphors

Various studies have been conducted to examine the effects of metaphors on consumer response in different contexts. In advertisements, using metaphors has been demonstrated to improve consumers' comprehension and consumers' attitudes (Phillipes, 2000). Involving metaphors in product designs can trigger surprise while users operate the product (Lin & Cheng, 2014). Based on these findings, we propose that product metaphors can play a role in facilitating consumers' comprehension of RNPs as well. However, different from a verbal metaphor that states the source clearly (e.g., in ads), consumers need to interpret a product metaphor by identifying the source themselves. Visual metaphors often carry certain levels of ambiguity (Van Rompay & Veltkamp, 2014), which may hinder consumers to identify the source precisely, leading to consumers' confusion. In the example of "Mother," consumers may link the product design to multiple sources, such as a Russian doll, 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. It is possible that the positive effects of product metaphors on consumers' comprehension of RNPs can be triggered with the help of textual clues. For the "Mother" smart home system, the textual clue of "Mother knows everything" is stated in the product introduction. In this way, the source is activated precisely and the possibility for misinterpreting is largely avoided. Therefore, this study will empirically test the effects of product metaphors on consumers' comprehension of RNPs in either the presence or absence of a textual clue.

The potential of product metaphors on facilitating consumers' comprehension

The facilitating role of product metaphors on consumers' comprehension of RNPs is similar to analogical learning that has been demonstrated to facilitate consumers' learning of RNPs. Analogical learning refers to knowledge transfer from the source to the target domain (Gregan - Paxton & John, 1997). The analogical learning 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).

Using a product metaphor in a RNP can relate a source to the RNP, which can trigger an analogical learning process, resulting in enhanced consumers' comprehension. The associations between the source and the RNP are essentially integrated when the RNP is embodied through a product metaphor (Hekkert & Cila, 2015). As the RNPs and the sources are conceptually related, the knowledge related to the source can be activated and transferred to the RNPs through analogical thinking, resulting in enhanced consumers' comprehension. Furthermore, in addition to the conceptual associations between a source and a RNP, product metaphors express such a conceptual association physically in the appearance of a RNP (Hekkert & Cila, 2015). The physical resemblance between the source and the RNP can help consumers to identify the source domain. Prior research has demonstrated that physical similarities between source and target can help consumers'

identification. By looking at the physical signal, consumers can retrieve the source from their memory and further map and transfer relevant knowledge (Forbus, Gentner, & Rattermann, 1993). Such identification is crucial for further mapping and transferring.

However, a precondition for facilitating consumers' comprehension of RNPs by triggering analogical learning through product metaphors is consumers' identification of the source. It is necessary that consumers can identify the source that designers intended. Otherwise, a different source can be activated, which will lead to consumers' confusion while mapping the similarities and a failure to transfer the relevant knowledge. If consumers fail to draw a conclusion, consumers' learning and comprehension of RNPs will be strongly reduced.

The uncertainty of identifying one specific source is caused by ambiguity essentially associated with visual metaphors. In comparison to verbal metaphors, visual metaphors often carry a certain level of ambiguity. Generally, consumers tend to perceive a visual metaphor more ambiguous when the distance between the source and target is large (Van Rompay & Veltkamp, 2014). A moderate level of ambiguity in visual metaphors presents consumers with a "puzzle to be solved" that further pushes them to pay more cognitive efforts to process (Kardes, 1988). Visual metaphors with a low level of ambiguity can be understood immediately, while visual metaphors with a high level of ambiguity lead to consumers' confusion and frustrations (Mick, 1992; Steen, 2004; Ward & Gaidis, 1990).

To reduce ambiguity, the provision of explanatory information can be helpful. By providing a textual clue to explain the product metaphors, consumers' identification of the source domain is directed to the one that designers intended and the possibility of interpreting it in different ways is avoided. Moreover, an explicit textual clue provides a link between the target and the source, which reduces the amount of cognitive efforts for identifying the source domain (Alba & Hutchinson, 1987). The positive effects of providing explanatory information have been demonstrated in consumers' comprehension of artworks (Leder, Carbon, & Ripsas, 2006) and visual metaphors in ads (Phillipes, 2000), and consumers' appreciation of packaging designs (Van Rompay & Veltkamp, 2014).

In line with the above, to trigger the positive effects of product metaphors while preventing the risk of consumers' misinterpretation, we propose that the presence of a textual clue can be helpful. When product metaphors are used in RNPs, a relatively high ambiguity is associated. Because RNPs are very different from what consumers know, the distances between RNPs and the source domains are large, and thus high ambiguity is associated with the product metaphors. Such a high level of ambiguity can hinder consumers' comprehension of RNPs because resolving the ambiguity is difficult for consumers. When processing a RNP embodied as a product metaphor, consumers need to firstly identify the source, next figure out in what ways the RNP resembles the source, and transfer the knowledge from the source to the RNP. If a high level of ambiguity is associated, consumers could encounter difficulty identifying the source, leading to confusion and frustration of understanding the similarities. However, if a textual clue is offered that provides a link to the source domain, the risk of consumers' failure to identify the source is reduced. More cognitive efforts can be directed to figuring out similarities

and transferring related knowledge, resulting in enhanced comprehension. Therefore, we expect that the presences of a textual clue with a product metaphor in an RNP can lead to enhanced consumers' comprehension.

H1: When product metaphors are used in RNPs, consumers' comprehension is moderated by the presence of a textual clue. Specifically, when product metaphors are used in RNPs, the presence of textual clues can enhance consumers' comprehension, in comparison to the absence of textual clues.

Method

An experimental study was conducted to test the hypothesis. To generate appropriate stimuli for this study, we conducted two design sessions and two pretests to generate and select product metaphors for the main study. In design session 1, participants were asked to generate metaphors at a conceptual level. Next, pretest 1 tested the relatedness between these metaphors and the RNPs. Design session 2 was conducted to integrate the selected concepts into physical forms. The designed product metaphors were validated in pretest 2.

Stimuli Creation

Design session 1

Twelve participants were invited to generate metaphors at a conceptual level. These participants were Master candidates who studied design (-related) subjects, so they were equipped with the expertise of searching for sources (Cila, Hekkert, & Visch, 2014).

RNPs were collected from the Consumer Electronic Show (CES) 2016, which is famous for launching innovative products. Among these innovative products, we selected RNPs that target the mass market and challenge consumers' learning. Six RNPs were selected: an alarm clock that wakes up people by odor, a pan that measures calories, an oral health monitor, a molecular sensor that detects the composition of objects, an activity measuring sensor for running, and a standalone shortcut button to control various digital devices. In the briefs, the key functions and benefits of the RNPs were described. The challenge was to think of other products or concepts that can help consumers to understand the innovative functions of these products. The concept of metaphors at a conceptual level was explained and two examples of existing product metaphors were given. Each participant was asked to think of metaphors for three RNPs. For each RNP, participants were first asked to generate as many metaphors as possible, and select one to finalize by sketching. For each RNP, two or three product metaphors were generated. For four RNPs, the same conceptual metaphors were mentioned several times by participants, but no consistent conceptual metaphors were generated for the two other RNPs (activity measuring sensor for running and standalone shortcut button), suggesting that no prominent association was found. We selected the four RNPs with the consistent conceptual metaphors for the next tests.

Pretest 1: soundness of the generated conceptual metaphors

To test whether the generated metaphors were considered sound to explain the innovative functions of the RNPs, pretest 1 was conducted. Soundness refers to the extent to which the deep underlying relational similarities are shared by the base and target (Gentner, Rattermann, & Forbus, 1993). A sound metaphor shares strong relationships, which is more likely to result in consumers' successful identification and comprehension.

Forty students (53% male) participated in pretest 1. In total, six conceptual metaphors were tested. Each participant evaluated three generated conceptual metaphors. The order of presenting them were randomized. Participants were first presented with the descriptions of the RNPs. They were explained that because these RNPs were highly innovative to consumers, companies aimed to use metaphors to explain these RNPs and their task was to evaluate whether the generated conceptual metaphors are proper to explain the RNPs. Next, following Gentner et al. (1993), soundness between the generated conceptual metaphors and target RNPs was measured by the following three statements: "the generated conceptual metaphor matches very well with the new product," "the generated conceptual metaphor shares essential similarities with the concept of the new product," and "the generated conceptual metaphor is strongly associated with the concept of the new product" from 1 (strongly disagree) to 7 (strongly agree) (α' ranging from = .77 to .92). In addition, the soundness in terms of experience was especially measured through asking participants to respond to the question "to what extent, is the usage experience of WK01 similar to experiencing a flower?" from 1 (not similar at all) to 7 (very much similar). Analyses were conducted separately for each generated conceptual product metaphor. Results are presented in Table 1. The generated conceptual metaphors with higher ratings on soundness and soundness in terms of experience were selected: the conceptual metaphor of flower for the alarm clock with odors (WK01), a scale for the smart pan with calories measurement (PN01), a mint container for the oral health monitor (XT01), and a magnifying glass for the molecular sensor (MS01).

Table 1: Results of pretest1: soundness between generated product metaphors and RNPs.

	Soundness	Soundness in terms of experience
	Mean (SD)	Mean (SD)
Target RNP: WK01	4.56(1.57)	4.00(1.80)
The conceptual metaphor of Flower		
Target RNP: WK01	3.98 (1.30)	3.05 (1.76)
The conceptual metaphor of Perfume		
Target RNP: PN01	2.87(1.46)	2.45(1.64)
The conceptual metaphor of Thermometer		
Target RNP: PN01	3.95 (1.35)	3.40 (1.39)
The conceptual metaphor of Scale		
Target RNP: XT01	3.85 (1.62)	3.75 (1.74)
The conceptual metaphor of Mint Container		
Target RNP: MS01	4.02 (1.32)	3.90 (1.37)
The conceptual metaphor of Magnifying Glass		

Design Session 2

The aim of design session 2 was to integrate the conceptual associations into physical forms. One professional designer was invited to design product metaphors. This designer had a Master degree in industrial design and had several years' experience in practicing product design. The descriptions of the four RNPs were provided, accompanied with the generated conceptual metaphors. It was highlighted that the generated conceptual metaphors were aimed to aid consumers' learning of the corresponding RNPs and the task was to translate the conceptual metaphors into tangible product designs. Four product metaphors were firstly generated in the form of sketches. Among these four product metaphors, the product metaphor of a magnifying glass for the molecular sensor (MS01) and a mint container for the oral health monitor (XT01) were selected to further 3D modeling and rendering for the usage of final stimuli (see table 2). The RNPs of WK01 (odor alarm clock) and PN01 (smart pan) were excluded from the research because the overall product category of clock and pan are mature, due to which categorization effects are likely to confound with the effects of product metaphors. For example, if WK01 (odor alarm clock) is employed in the shape of a flower, the category of flower is activated and the category knowledge can possibly be activated as well. This categorization can confound with the analogical learning process that triggers by the presence of product metaphors, which challenging the validity of the experiment.

Consequently, the design of XT01 and MS01 for the condition with product metaphors resembles a typical mint container and a typical magnifying glass. For the condition of RNPs without product metaphors, the original product appearances were used as stimuli. The brand information was digitally removed. For both conditions, the color and details of product appearances were made as similar as possible. The pictures of RNPs were presented in the same background, size and perspective for both conditions (see table 2).

Table 2. Results of design session 2: stimuli for conditions with and without product metaphors for both product categories

	With product metaphor	Without product metaphor
XT01		
MS01		

Pretest 2: relatedness between physical form and the intended product metaphors

Pretest 2 aimed to test whether people were able to relate the physical form to the intended conceptual metaphors for the two target RNPs.

A 2 (product metaphor: present vs. absent) \times 2 (product category: oral health monitor vs. molecular sensor) mixed experiment was conducted, with the presence of product metaphors as between-subject factor and product category as within-subject factor. Each participant was assigned to one of two conditions and evaluated two products. The order of the products was counterbalanced. Forty participants were collected (mean age= 21.87, 56.4% male).

In pretest 2, for both conditions, we measured relatedness between generated product metaphors and RNPs, novelty, and attractiveness of generated product metaphors. The relatedness was measured in terms of the space for interpretation and the strength of relatedness. By measuring the space for interpretation, we aimed to learn whether the generated product metaphors allowed for multiple interpretations. We attempted to learn whether consumers can identify the source intended when seeing the product metaphors. The space for interpretation was measured by an open question “after seeing the picture of the product, what comes to your mind immediately? Could you relate it to any familiar things (e.g., familiar product, animal, plant, or person)? Please write them down below.” Next, the strength of relatedness was measured, aiming to learn the extent to which the generated product metaphors were strongly associated with the source intended for. Participants were asked to respond to the three statements “by seeing the picture of this product, I am confident to draw the conclusion that this design is related to a mint container/magnifying glass,” “by seeing the picture of this product, I am able to relate it to a mint container/magnifying glass,” and “after seeing the picture of this product, a mint container/magnifying glass immediately comes to my mind” on 7-point scale from strongly disagree to strongly agree (α 's ranging from .71 to .91). In addition, to avoid confounding effects, attractiveness and novelty were measured. Attractiveness was measured by 7-point scale anchored by “ugly/beautiful” and novelty was measured by “common/novel.”

Results were analyzed separately for each product category. For the molecular sensor, in the open question, 18 out of 20 participants mentioned a magnifying glass in the product metaphor condition. For the oral health monitor, 17 out 20 participants mentioned a mint container in the product metaphor condition. In addition, t-tests were conducted with the presence of product metaphors as the independent variable, and relatedness, attractiveness, and novelty as the dependent variables. Results revealed that participants' ratings differed significantly on relatedness for the molecular sensor $t(38)= 17.45, p<0.001$ and the oral health monitor $t(38)=11.029, p<.001$. No significant differences were detected in terms of attractiveness and novelty (see table 3).

Table 3. Results of pretest-2

	Relatedness	Novelty	Attractiveness
	Mean (SD)	Mean (SD)	Mean (SD)
XT01 with product metaphor	5.73 (1.28)	3.05 (1.05)	3.25(1.21)
XT01 without product metaphor	2.12 (0.72)	2.95 (1.10)	3.75(1.02)
MS01 with product metaphor	6.53 (0.81)	3.50 (1.43)	4.35 (1.27)
MS01 without product metaphor	1.82 (0.89)	3.40 (1.60)	4.40 (1.43)

Main study

Design and participants

The main study used a 2 (product metaphor: present vs. absent)×2 (textual clue: present vs. absent)×2 (product category: oral health monitor vs. molecular sensor) mixed experimental design, with the presence of product metaphor and the textual clue as between-subject factors and product category as within-subject factor.

One hundred and fourteen participants were collected (mean age=43.28, 36.9% male) from a consumer panel. People who were younger than 55 years old were invited to participate in this study because older people could have difficulty with accepting new products (Loudon & Bitta, 1993).

Final Stimuli

The product designs from pretest 2 (product metaphors: present vs. absent) were combined with the textual clue (present vs. absent) to create the final stimuli for the main study. The textual clue was created “it is like a mint container/magnifying glass.” This textual clue intended to explain the integrated product metaphor by informing consumers about the source domain.

Procedure and measurements

Each participant was assigned to one of the four conditions and evaluated two products on several measures. The order of presenting two products was randomized. A short product description for each product category (see table 4) was presented to participants together with the final stimuli. The short product descriptions were identical across four conditions.

Table 4. Product descriptions

Product category of XT01
XT01 is a portable device to improve the oral healthcare by monitoring breath quality and hydration levels. XT02 draws a sample of air from the mouth and analyzes this sample by measuring the organic compounds released by various bacteria. Subsequently, XT02 reports the state of the oral and breath health to the smartphone app within seconds. Furthermore, XT02 tracks the changes of breath quality and hydration levels in time, and provides personalized guidance on cleaning routine and diet. XT02 is small and easy to carry.
Product category of MS01
MS01 is a molecular sensor that enables people to examine objects for their chemical composition and identification. MS03 projects a light source to illuminate the object at 2cm from the object. By measuring the interaction between the light and the molecular vibrations of the object, MS03 can detect the composition of the object and provide results on the smartphone app within seconds. Furthermore, MS03 can detect compositions for all kinds of things, such as objects, food, medicine, etc. MS03 is small and easy to carry.

Comprehension of the RNP was measured by asking participants to indicate to what extent that they agreed the following four statements (Feiereisen, Wong, & Broderick, 2008): “after looking at the picture of the product and reading the description, I found the product” anchored by “difficult to understand/easy to understand” and “confusing/straightforward” from 7-point scale, and “after looking at the picture of the product and reading the description, I completely understand the various features of this new product,” and “I understand what the main benefits of this product are” on 7-point scale from 1 (strongly disagree) to 7 (strongly agree) (α 's equaling to .888 to .890). To avoid confounding effects, attractiveness of product appearances was measured by two 7-point scale items: “ugly/beautiful” and “unattractive/attractive” (Pearson's r 's equaling to .69 to .73).

Results

Manipulation check

To test the success of the manipulation of product metaphors, a 2×2×2 mixed ANOVA was conducted with the presence of product metaphors, presence of textual clues, and product category as independent variables, and the ratings of relatedness as the dependent variable. The results confirmed the success of the created stimuli ($F(1, 110) = 646.14, p < .01$; $M_{with\ product\ metaphor} = 6.26, M_{without\ product\ metaphor} = 1.98$). For both product categories, in comparison to when a product metaphor was absent, participants reported significantly higher scores on the measure of relatedness when a product metaphor was present. No effects were found for the presence of a textual clue and the interaction between a textual clue and product metaphor ($p > .10$).

Test of hypotheses

H1: Effects of the presence of product metaphors and textual clues on consumers' comprehension of RNPs

To test hypothesis 1, a 2×2×2 mixed ANOVA was conducted with the presence of product metaphors, the presence of textual clues and product categories as independent variables, and consumers' comprehension as dependent variable. No main effects of the presence of product metaphors and the presence of textual clues were detected ($p > .10$). A significant interaction effect was found between the presence of product metaphors and textual clues on consumers' comprehension ($F(1,110) = 11.67, p < .05$) (see figure 4). Across two product categories, when product metaphors were present, participants reported better comprehension when the textual clue was provided, in comparison to the absence of the textual clue ($F(1, 52) = 7.33, p < .05$; $M_{with\ textual\ clue} = 5.34, M_{without\ textual\ clue} = 4.51$). When a textual clue was absence, the presence of product metaphors resulted in a significant decrease of consumers' comprehension ($F(1, 54) = 7.67, p < .05$; $M_{with\ product\ metaphor} = 4.51, M_{without\ product\ metaphor} = 5.37$), which suggests that the sole presence of product metaphors confuses consumers. For both product categories, the pattern of means were analyzed separately. The means for the variable consumers' comprehension were in the expected direction (see table 5). These results provide support for H1.

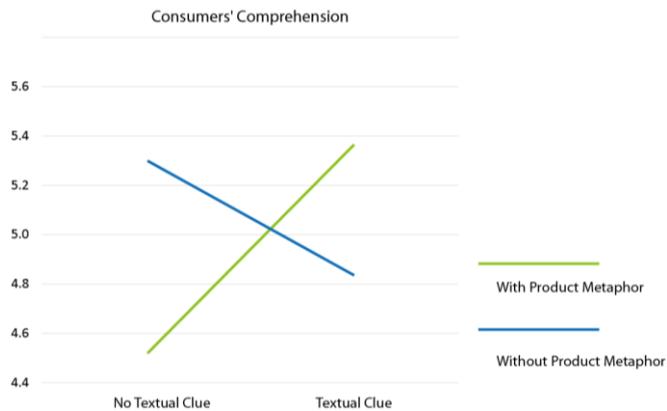


Figure 4. The interaction effect of the presence of textual clues and product metaphors on consumers' comprehension

Table 5. Results of main study: adjusted means for consumers' comprehension, relatedness, and innovativeness by product category.

		With product metaphor		Without product metaphor	
		With textual clue	Without textual clue	With textual clue	Without textual clue
XT01	Consumers' comprehension	5.44	5.10	5.08	5.62
	Relatedness	6.22	5.94	2.72	2.33
	Innovativeness	5.58	5.44	5.39	5.28
MS03	Consumers' comprehension	5.25	3.92	4.54	5.11
	Relatedness	6.42	6.46	1.51	1.33
	Innovativeness	5.51	5.36	5.51	5.59

General Discussion

This study demonstrates that using product metaphors can improve consumers' comprehension of RNPs, but only when a corresponding textual clue is provided as well. Because the distance between a product metaphor and a RNP is generally large, consumers face a high level of ambiguity when identifying the source. The presence of a textual clue directs consumers to the source that designers intended and the risk of identifying a different source is reduced. As a result, the correct source is activated, which leads to enhanced consumers' comprehension.

These findings contribute to previous research on product metaphors. Although previous studies suggest that product metaphors could facilitate consumers' comprehension of RNPs (Hekkert & Cila, 2015; Phillippe, 2000), empirical studies are lacking to support designers to make effective use of product metaphors. Results of this study contribute by empirically demonstrating that the sole presence of product metaphors is insufficient to enhance consumers' comprehension. Consumers' comprehension can be improved by the presence of both product metaphors and textual clues that state the source clearly.

These findings can provide valuable support for design managers and designers in practice. For design managers, the results of this study suggest that the positive effects of product metaphors on consumers' comprehension can be triggered by accompanying the product appearance with textual clues. If design managers decide to embody RNPs by using product metaphors, they need to collaborate with marketing managers to make sure that marketing materials state the source clearly. Otherwise, the sole presence of product metaphors will lead to confusion and a decrease in consumers' comprehension.

Although positive interaction effects of product metaphors and textual clues on consumers' comprehension of RNPs are found, designers should interpret the results from this study carefully. The positive effects were found based on strong soundness and relatedness between product metaphors and target RNPs. Thus, while designing, designers need to carefully select sources and integrate them into physical forms precisely. The sources should be strongly related to the targeted RNPs in terms of the benefits they provide, and also align with the target RNPs in terms of experience. Moreover, consumers should be able to easily identify the sources based on the physical forms.

Limitations and future research

To facilitate consumers' comprehension of RNPs, marketers and designers can trigger consumers' learning through making use of accumulated knowledge. Specifically, consumers' learning can be facilitated through category-based and analogy-based knowledge transfer (Hoeffler & Herzstein, 2011). For category-based knowledge transfer, a RNP is labelled as one of member from an existing product category. Then, the category knowledge will be transferred into the RNP. Differently, for analogy-based knowledge transfer, only certain benefits from the source product category will be transferred into the RNP. In this study, we aimed to examine the effects of RNPs on triggering analogy-based knowledge transfer. Thus, we selected those RNPs that do not belong to any existing product category, in order to prevent potential confounding effects

resulting from category-based knowledge transfer. Future research can examine the effects of product metaphors on consumers' comprehension of RNPs that belong to a mature product category. Specifically, it could be possible that both category-based and analogy-based knowledge transfer are triggered, which together contribute to consumers' learning. In the example of WK01 (odor alarm clock), when it is embodied in the product metaphor of a flower, it is possible that the categories of a clock and a flower are activated. Thus, consumers can transfer the knowledge of a clock to the RNP and consumers can also relate with the innovative function of releasing odor, leading to enhanced consumers' comprehension of the RNP. However, it could also be possible the presence of a product metaphor triggers the analogy-based knowledge transfer but hinders the category-based knowledge transfer. Following the example of WK01, the flower product metaphor could facilitate consumers' retrieval of characteristic of a flower to have a smell, but it hinders consumers' recognition of the product as an alarm clock. The shape of a flower conflicts with the prototype of an alarm clock, and thus consumers may not recognize it as a clock, resulting in reduced comprehension. Therefore, future research can investigate the effects of using product metaphors in RNPs that belong to mature product category. It is necessary to examine which mechanism dominates consumers' processing.

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About the Authors:

Peiyao Cheng is a PhD candidate in School of Design, Hong Kong Polytechnic University. Her research focuses on the influence of product appearance on consumer response to product innovations.

Dr. Ruth Mugge is associate professor of consumer research in the Faculty of Industrial Design Engineering at Delft University of Technology. Her main research focus is on understanding consumer response to product design at purchase and during ownership.

Prof. Cees de Bont is dean of School of Design, Hong Kong Polytechnic University. His research interests are in the areas of early concept testing of consumer acceptance, consumer behaviour, innovation adoption, and networked innovation.