

TOWARDS A BETTER UNDERSTANDING OF THE INFLUENCE OF VISUAL REFERENCES ON CONSUMER AESTHETIC PERCEPTION

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ABSTRACT

When viewing a product for the first time, a consumer's aesthetic perception is based on their knowledge of other products, artefacts, and concepts. These mental images function as visual references for consumers and affect the processing fluency of the new product. Designers frequently use visual references as inspiration during the research stage of the design process. It has been documented, however, that there is a gap between designer intent and consumer response; Consumers do not always realize the intent of designers nor draw on the same visual references when perceiving a product, which can reduce their processing fluency of new products.

Visual references differ from one consumer to the other which make them difficult to study. In this paper, we argue for a new way of studying visual references: by analyzing the cognitive process that occurs when consumers view a new product and recognize aspects of that product that are similar to visual references in their memory. We present a framework of three approaches for recognizing this similarity and implications for design practice.

Keywords: New product development, Design cognition, Emotional design, Aesthetics, Consumer response

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1 INTRODUCTION

When faced with a new product, consumers perceive its aesthetics based on other products, artefacts, concepts or living things they have previously seen or interacted with (Hekkert and Leder, 2008). These previous products or concepts act as *visual references* (Crilly et al., 2004) that the consumer employs in developing their perception of the product. Consumers employ these references, knowingly or unknowingly, whenever they are presented with a new product.

These references influence multiple cognitive processes, two of which are particularly relevant to designers: processing fluency, by which consumers interpret object stimuli with ease and subsequently feel positive affect (Reber, 2011) and automaticity, by which consumers develop habits that reduce the mental load taken to make purchase decisions. These habits enable repeat purchases (Liu-Thompkins and Tam, 2013) and are an important part of customer loyalty (Mahr et al., 2022).

Visual references are frequently used in design and marketing to promote new products. For example, products are often made in a retro style (an old style) to encourage nostalgia for a past era (Orth and Gal, 2014). In sports, jerseys are often designed using similar patterns from legendary teams to build excitement for a new season. In product design, visual references are cultivated by designers as part of their design process. Typically, they are used for inspiration in generating multiple concepts, and some aspects of these references may find their way into the product concept (Eckert and Stacey, 2000; Gonçalves et al., 2014; Jagtap, 2017).

Although these references are included to get the attention of consumers, there is a gap between designer intent and consumer response (Crilly et al., 2008). Consumers often do not understand the intent of designers, nor draw on the same visual references, when examining a product. Instances of this mismatch could decrease the processing fluency and increase the mental workload that consumers use when perceiving a product. Crilly et al. (2004) proposed that a better understanding of visual references in consumer response is important and wondered if a range of references that exist for the consumer could be generated. In our analysis, this development could function as a solution to meet this designer intent–consumer response gap during the design process and would be an extension of the current practice of designers to cultivate inspirations for their design concepts (Jagtap, 2017).

To develop a range of references that exist for consumers requires a better understanding of the cognitive processes at work when consumers recognise features of new product stimuli that recall visual references from their memory. Visual references vary widely from one consumer to another, as they are based on the experiences, cultural background, and other personal factors. We contend that while visual references are different for each consumer, this cognitive process of recognition is uniform across consumers and proceeds in three ways, each aided by how the consumer perceives similarity between the new product under observation and their visual references. We present this framework in the later sections of the paper.

This paper discusses visual references by reviewing this construct and analysing the visual studies and aesthetics design literature. We demonstrate that while the term has not achieved wide usage, many researchers have implicitly studied or discussed it in their work. In the following sections, we discuss where visual references sit in design literature, how these references are formed, show examples of visual references in previous studies, and finally we present a framework designers can use to better understand how consumers employ visual references in recognising product features. This framework will be subsequently tested in future work.

2 VISUAL REFERENCES IN DESIGN LITERATURE

With regards to aesthetics, design research has historically focused on consumer response (Bloch, 1995; Demirbilek and Sener, 2003), consumer perception (Mumcu and Kimzan, 2015), designer intent (Cheutet et al., 2008), design team creativity (Han et al., 2021), and company brand perception (Ranscombe et al., 2012). Visual references, specifically as perceived by consumers, are understudied in aesthetic literature. However, in investigating consumer response to aesthetics, some researchers have indirectly described visual references. In this section, we provide an overview of two such studies that show where visual references fit within consumer aesthetic perception.

Crilly et al. (2004) presented a framework for design as communication between a design team and a consumer, and placed visual references as part of the “context of consumption” that helps the consumer understand the product. They defined six categories of visual references: stereotypes (also

called prototypes), which is the baseline perception of a product type; similar products, which are other products in the same category; metaphors, which are concepts derived from other product types or analogies; characters, which evoke comparison to living things; conventions, which use cultural norms (such as traffic light colours); and clichés, which happen when products follow a current fad.

The second study described visual references without explicitly defining them. [Locher et al. \(2010\)](#) presented a framework for aesthetic interaction between a person and an artefact. They defined personal taste, level of aesthetic sophistication, general knowledge, and cultural background, among others, as factors in the “person context” that influences a consumer’s aesthetic experience of a product. These factors are simply representations of visual references. In their study, they describe the “person context,” the “artefact context”, and the interaction between both contexts as the three levels of aesthetic experience. Both studies built on others in the communication or information processing literature. Crilly and his colleagues derived their consumer response to the visual domain framework from [Shannon's \(1949\)](#) basic model of communication which includes a source (the designer or design team), a transmitter (the product), a receiver (the consumer), and a destination (the consumer response).

Locher and his colleagues built on [Atkinson and Shiffrin's \(1968\)](#) information processing theory employing [Baddeley's \(2007\)](#) working memory model where the “central executive” receives sensory input (from observation of the product) and draws on long-term memory (to manipulate or interact with the product).

As described above, these two studies placed visual references within the consumer aesthetic perception of product design and provided a framework for understanding what they are. However, neither discussed how consumers develop visual references, which is important to understand the cognitive processes at play when consumers recall them. We discuss this in the next section.

3 HOW DO WE FORM THESE VISUAL REFERENCES?

As visual references may differ from one consumer to another, it is important to understand how they are formed. We discuss three approaches from psychology and neuroscience literature that describe how consumers form these references, which in turn, provide designers with a deeper understanding of their consumers.

3.1 Conceptual scaffolding

[Williams \(2015\)](#) presented three instances of “conceptual scaffolding,” a cognitive process where knowledge developed as an infant serves as the base of abstract concepts i.e., these concepts are scaffolded onto the knowledge. As an example, he presented the idea of *close friendships* which implies short distance. In his analysis, physical experiences of proximity (for example, with temperature or distance) can activate the concept of closeness and then inform emotional responses and thoughts (such as how the product will work). This work implies that design concepts like spatial closeness of product features activate feelings of psychological closeness i.e., they act as visual references for the closeness metaphor. For example, buttons in a game controller that are beside each other can activate the idea that they work together. In the same way, products that are designed for the purpose of connection between people should incorporate some aspects of spatial closeness for consumers to recognise.

3.2 Repetition

Visual references may also be formed by repetition. In visual studies, when a stimulus is repeated it is more quickly identified. [Jacoby and Dallas \(1981\)](#) explained that this ease of identification is due to changes in the mind of the perceiver, which make the object easier to process. In the same way, consumers become aware of product features through continuous exposure.

The repetition perspective is represented in aesthetics design literature. [Coates \(2003\)](#) described positive aesthetic impression as a consumer-perceived outcome based on a combination of *information* and *concinnity* – two contrasting factors that concern the novelty and order (i.e., the logical arrangement of features) of the product respectively. Novelty and order are notions established by repeated exposure to products of the same type.

[Landwehr \(2015\)](#) explained that aesthetic features that are initially disliked when introduced can become preferred over the lifetime of a product due to repeated exposure, using evidence of the response to the trunk lid design of the BMW 7-Series in 2001 (which was panned) and the Mercedes S-Class of 2005 (which was acclaimed) even though the designs were virtually identical.

3.3 Motivation and reward

In their mathematical investigation of how aesthetic preferences are developed over time, [Aleem et al. \(2020\)](#) presented descriptions for motivation and reward. Motivation, defined as the internal drive of an individual to act given an input (in this case a product), and reward, defined as the aesthetic value realised after an action (in this case the use of a product), are characteristics of a consumer affected by their exposure to a product.

If a consumer purchases a product, and its use matches their perceived reward, they learn the properties of the product that enable their future predictions to better match reality. For example, when first faced with a choice of comfort between two seats made of leather and wood, consumers learn that leather seats are more comfortable than wood and add that to their knowledge of both materials. If presented again with products made of leather or wood, they will refer to their knowledge of leather's comfort in their aesthetic perception of the new products. Further, the authors describe that when the products are sufficiently familiar to the consumers, they may also develop perceived rewards from an examination of representations of the product, such as a picture or image of it.

4 VISUAL REFERENCES IN ACTION

As previously mentioned, the term *visual references* appears to not have gained widespread acceptance in the literature. However, many studies investigating aesthetic response and visual perception in product design have provided results that show visual references in action (either perceived by study participants or inferred by the researchers), whether that was the stated objective of the study or not.

Exploring these studies is important, as it provides evidence for the underlying cognitive processes by which visual references manifest. As a tool for discussion in this section, we use four of the categories of visual references described by [Crilly et al. \(2004\)](#) from Section 2 (stereotype, similar products, metaphors, characters) to show instances of visual references in aesthetic studies.

[Law et al. \(2017\)](#) studied the influence of visual aesthetics in the design of scoliosis braces on user acceptance among young female adults and teenagers in Hong Kong who had adolescent idiopathic scoliosis or previously wore braces. The study interviewed the respondents and analysed their feedback in five categories including colour perception and mental imagery. They found that respondents associated the nude colour of the brace with ugliness as well as with medical disability. When elements were added to the braces for purely aesthetic purposes, respondents described positive affect saying they would love to wear them. Both responses describe Crilly's stereotype and metaphor categories of visual references ([Crilly et al., 2004](#)).

[Maya and Betancur-Rodríguez \(2017\)](#) studied prototypicality as a cognitive variable in the design of pepper mills. In the first of their three studies, they asked product design engineering students to sketch the most typical pepper mill and then the researchers generated the prototypical average of all sketches. In their second study, they conducted an online survey with new respondents who rated originality, aesthetics, and typicality from a set of 20 pepper mills. The researchers found that the prototypical shape from their first study was visually similar to the highest rated pepper mill for typicality in their second study. This again matches Crilly's stereotype category of visual references.

[Bluntzer and Ostrosi \(2019\)](#) were interested in how people perceive the place of origin of car brands and studied this among university students in Europe. They created a questionnaire and stripped all brand information from the car images, as well as developed two functions to describe completeness (the consumer's degree of recognition for a car's country of origin) and discrimination (the consumer's degree of inability to recognize all other countries). They found that the respondents used the geometry and details of cars to define their country of origin: smaller cars were ascribed to be of European origin while bigger cars (such as SUVs) were ascribed to be American. They also reported that respondents found it difficult to assign countries to cars that targeted a global audience i.e., cars that had no culturally discerning features. Their study described Crilly's similar products and characters categories of visual references.

In the three studies described above, the participants employed visual references in order to make aesthetic judgments. They did this mostly unaware of the cognitive process involved in recognizing aspects of the product stimuli that are similar to visual references in their memory. In the next section, we explore how this visual cognition process might occur.

5 RECOGNIZING THE SIMILARITY BETWEEN VISUAL REFERENCES AND PRODUCT STIMULI

Here, we present three groups of cognitive processes and studies from literature that have demonstrated these processes as part of their methodology or discussed them in their results. While the first two have been previously discussed in the literature as ways of thinking about similarity, we introduce the third process based on design practice and analysis of the literature. These processes show how product stimuli serve as prompts that consumers, on seeing their features, recognize the product's similarity to visual references in their memory. While the references will differ from one consumer to the other, the processes are uniform.

As a tool for discussion, we align each process to [Locher et al.'s \(2010\)](#) three layers described in Section 2: the “person context” relating to the consumer, the “artefact context” relating to the product, and the interaction between the two contexts as the third layer. By using these three contexts, we show how designers can explore the visual reference space that exists for any pair of product type and consumer persona.

5.1 Recognizing similarity by design elements

One way consumers recognize the similarity between their visual references and a product being observed is by their design elements, which are the discernible features of a product: its geometry or form, dimensions, textures, materials, colours, graphics, and details ([Crilly et al., 2004](#)). In this way, visual references are recognised by the similarity of the design elements e.g., glass cups and vases are considered similar if both products are circular in shape (see Figure 1).



Figure 1. The tumbler (left) and vase (right) shown above have similar design elements: circular form, and glass as the material. Photos from the Cooper Hewitt Collection.

In proffering an alternative product recommendation method for e-commerce websites, [Kobayashi and Takeda \(2020\)](#) developed a mathematical model for predicting consumer preference based on the colour, material, and details of previously “favourited” items. In their study, they confirmed their model with consumers who had provided their e-commerce data. These consumers were asked to make their choice from a selection of products they had not purchased before, and they mostly selected options that were similar in colour, material, or details to their previous purchases, meaning consumer choice followed similarity of design features as explained by visual references.

This recognition process aligns with Locher et al.'s *artefact context* layer. Design elements are fungible aspects of product design specified by the designer or design team and embodied by the product. In fact, this cognitive method of recognizing similarity has also been used to develop design methods. Using smartphones and cars, [Ranscombe et al. \(2012\)](#) presented three methods of studying similarity with

regards to form: feature proportion analysis, feature shape analysis, and feature orientation analysis. Different products of the same type can be compared using these methods to evaluate their similarity.

5.2 Recognizing similarity by product type

Another method of recognizing similarity is by similar product type. Consumers retain the visual information of products they have used and can recognize similar features if reminded via stimuli (see Figure 2). Interestingly, consumers may also recall visual references of this type absent of stimuli; this phenomenon is useful when studying the typicality of a design or form.

In such studies with consumers, researchers ask respondents to sketch their idea of the product (Hung and Chen, 2012; Maya and Betancur-Rodríguez, 2017) and then analyse the sketches to generate a typical design. Usually, the responses are similar enough that algorithmic image analysis is not required to define the typical shape, and the researchers trace out the equivalent shape easily. This shows that consumers have similar visual references within a product category and should recognize when a product's form exhibits those references.

Within this method of identifying visual references, consumers may also recognize qualitative attributes of the product i.e., how well a product performs its function or displays non-functional characteristics. A chair may be regarded as comfortable, for example, even though the consumer is only visually observing it. This phenomenon is used in studies that employ the semantic differential methodology (Hsu et al., 2000; Sevenser, 2003) to determine the aesthetic properties of a sample of products.

This recognition process aligns with Locher et al.'s *person context* layer. Consumers require previous experience with products that have the same function to recognize a new product with similar function in this way. Also, consumers may not recognize a product's function but recognize the function of its parts e.g., a product may have a speaker and a screen and consumers may infer that the product can play sounds and display information on the screen.



Figure 2. Two thermostats with different operation and design elements. Either can be recognized by their category of home devices. Photos from the Cooper Hewitt Collection.

5.3 Recognizing similarity by object interaction

Consumers may also recall visual references by physically interacting with the product stimuli (see Figure 3). Affordances provided by products are often utilized in different products in new ways; these affordances show consumers how to use the product. This perspective has been used in the study of interfaces.

Still and Dark (2013) explored the underlying mechanisms that explain how affordances arise and affect the cognitive system. They argued that there are two cognitive processes that may be invoked by perceived affordances: an automatic process where consumers are able to use a product with low attention, and a controlled process where consumers need high awareness. The subconscious decision between both processes depends on if the product's design is consistent with the consumer's present and past interactions with similar devices.

This recognition process aligns with Locher et al.'s *interaction between contexts* layer. By manipulating the product, mostly by touch, consumers can see more aspects of its features that could help them recognize visual references. This paper's first author observed this as part of his design

practice, when sharing a toy designed for children to study the multiplication table with an interested parent. The parent watched the rotating mechanism and mentioned that it reminded them of a container of birth control pills, a product the first author had no experience with. On comparing the two products, each used rotation as a way to reveal an aspect of the design: the multiple in the case of the math toy, and the pill in the case of the birth control container.

This recognition process is also demonstrated when consumers manipulate a product and discover a way it fits into a larger system or product. A simple example of this is when playing a puzzle game and rotating a piece reveals where it fits in the puzzle. Without that interaction between consumer and product, the recognition would not be realized.



Figure 3. A kitchen timer and door handle are shown above. Both products have different design elements and are not of the same category. However, both allow for rotation and can be recognized as similar in that way. Photos from the Cooper Hewitt Collection.

6 IMPLICATIONS FOR DESIGN PRACTICE AND FUTURE RESEARCH

To bridge the gap between designer intent and consumer response, it is important for designers to study the visual references that exist for the intended consumer. In this paper, we have proposed three cognitive methods that consumers use in comparing product stimuli with those in their memory.

In many professional product development organizations, designers do not interact with consumers of their products; for example, in multinational companies, the design team may be in a different continent from the consumer. The marketing team represents the consumer in these product development contexts and defines the consumer demographic and requirements (Bailetti and Litva, 1995).

The cognitive methods discussed in this paper can be used by design and marketing teams to generate product concepts as well as select the concept to be manufactured. In addition, designers can target one of these cognitive processes in their design. For example, when designing a second version of a successful product already in the market, designers might retain the product interaction from the first version even though they change the colour and materials, i.e., the design elements, in order to signal similarity to their consumers. An example of this was seen when Apple introduced the iPhone 5C in multiple colours even though the user interactions were unchanged from the iPhone 5.

However, for a product that is a new entrant to the market, the designers would prefer a unique form from others on the market while having enough features to describe what type of product it is, i.e., help consumers recognize similarity by product type. An example of this was seen when the Nest Learning Thermostat was launched; the circular, no-button design of the thermostat looked very distinct from the common multiple-button, white, rectangular Honeywell devices. In order to signal the product's function, the design of the Nest Learning Thermostat had only two visible items on the display screen: the temperature and the control setting i.e., heating or cooling. Consumers viewing the product for the first time used those cues to know what type of product it was.

Academically, a comparison of the cognitive processes introduced here and the two general views in object recognition psychology (i.e., the feature-based view that object knowledge is grounded in sensing of the features and the category-based view that object knowledge is organized by thematic categories - see Geng and Schnur, 2016 for a review) might reveal additional avenues for future work, and implications.

A future extension of this work would be an empirical investigation of these three cognitive processes. We are interested in testing the boundaries between the three: are there products that signal one of these processes over the others? Are there any limitations for consumers in processing one way over the others? In addition, we are interested in developing concept generation and selection methods for designers that leverage our understanding of visual references in product design and manufacturing.

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Images in this paper are courtesy of the Cooper Hewitt Collection, the Smithsonian Design Museum. Below are the citations for each image, in order of appearance:

- Tumbler; glass; H x diam.: 10.9 x 8.8 cm (4 5/16 x 3 7/16 in.); 1945-34-13
- Vase; Made by Louis Comfort Tiffany (American, 1848–1933); glass; H x diam.: 13 x 8 cm (5 1/8 x 3 1/8 in.); Bequest of Joseph L. Morris; 1966-55-12
- Magic Stat Thermostat; Designed by Cousins Design; Manufactured by Honeywell, Inc. (United States); USA; plastic, electric, electronic components; in box: 4.5 x 18 x 23 cm (1 3/4 x 7 1/16 x 9 1/16 in.); Gift of Anonymous Donor; 1993-58-2
- T-86 Round Thermostat; Designed by Henry Dreyfuss (American, 1904–1972); Office of Henry Dreyfuss Associates (United States); Manufactured by Honeywell, Inc. (United States); USA; metal, plastic; H x diam.: 4.5 x 8 cm (1 3/4 x 3 1/8 in.); Gift of Honeywell Inc.; 1994-37-1
- On the Dot Kitchen Timer Timer; Designed by Morison S. Cousins (American, 1934 – 2001); Manufactured by Tupperware Corporation (United States); USA; plastic, metal; 9 x 10.4 x 9 cm (3 9/16 x 4 1/8 x 3 9/16 in.); Gift of Tupperware and Morison S. Cousins; 1996-102-1
- Leveron Door Handle Attachment; Manufactured by Lindustries; molded plastic; H x W x D: 7.6 × 16.5 × 15.2 cm (3 in. × 6 1/2 in. × 6 in.); Gift of Lindustries; 2014-47-2

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