

Applications of Metaphor Theory to Product Design

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Abstract: This paper introduces applications of Andrew Ortony's salience imbalance theory and Ellen Winner's domain distance theory to metaphors in the area of industrial design. This study classifies features of targets and sources in a metaphorical product into (1) visual (or form) level, (2) action levels (either taxonomy or category at macro level, or behavior or action at micro level), and (3) image (or symbolic) level. Salience imbalance is tested through feature matching, and domain distances are estimated by multi-dimensional scaling. Sixteen participants were asked to identify the sources of five citrus squeezers, and then determine the visual-level and action-level features of the targets and sources in priority order, respectively, as well as the similarity between the targets and sources. Results reveal salience imbalance theory is not completely explainable for metaphorical products, and suggest the positive relationship between metaphoricity and creativity. This study proposes a four-quadrant framework to sort the metaphorical products with different creativity levels.

Keywords: *Metaphor, salience imbalance theory, domain distance theory, industrial design*

1. Introduction

Metaphor is a device for seeing something in terms of something else [1]. Lakoff and Johnson claimed that our conceptual system is fundamentally metaphoric in nature, and Lakoff further asserted that metaphor is not just about language, but also about thought in the way that we conceptualize one domain in terms of the other [8]. Still, metaphor is the way we understand new things is to conceive of them in terms of things we already know. Since design is about the processes of designers to create new products, and the new products conceived by users, the role of metaphor to play in design is twofold. First, metaphor in design processes can help designers define unfamiliar design problems, generate new design solutions, as well as communicate their designs with the stakeholders by juxtaposing something unfamiliar or new with known situations [3]. Second, metaphor within products can be a powerful tool for conceptualizing, orienting, and personifying products [12]. In a sense, we can say design is intrinsically about metaphor, because creative design often refers to such processes or products of juxtaposition as metaphor.

Metaphor is widely viewed as a selective mapping of features between two conceptual domains, namely, the target and source [6, 7, 15, 16]. Andrew Ortony's salience imbalance theory claims that metaphoricity involves a difference in relative salience among the matching feature from the target and source. What distinguishes metaphor from literal similarity is an asymmetry in the salience of the features that are shared between the target and source. In the area of language or rhetoric there are many observations that metaphors tend to be strongly

directional, but salience imbalance theory is in question in the area of industrial design. Applying Ortony's imbalance theory to the metaphor in visual arts, Ellen Winner pointed out that a good metaphor is determined by two distances between the target and source [17]. The distance between the domains of the target and source of a metaphorical product should be maximized, while the distance between the metaphorical product and typical products within the same domain should be minimized.

Shen distinguished two models of metaphor in terms of domain: domain-as-schema and domain-as-taxonomic category [13]. Given two features (consisting of attributes and relations) which are equally mappable from source domain to target domain, the mapping preferences from source to target domains depends on which model is employed. The schematic model prefers a relation over an attribute, and a higher order over a lower order relation. In contrast, the categorical model prefers a high salient (or diagnostic) feature of the concept in question within its respective category, over a low salient one. This interpretative principle underlies various theories of metaphor [9, 14, 16].

Recent metaphor researches turn to visual metaphors. For instance, Forceville [4-5] proposes a theory of pictorial metaphor, which was based on Carroll's theory of film metaphor, to analyze metaphors employed in advertisement [2]. However, their focus is simply put on visual form instead of behavioral function. Because behavioral aspects are not less important than visual aspects to constitute a product, an appropriate theory of design metaphor cannot ignore it. In industrial design, a product is usually viewed as an object that comprises three different elements: form, function and image (or symbolic, sense, meaning). In contrast to this object-based viewpoint, Ortony, Norman and Revelle (2004) suggest a cognitive viewpoint of processing of visceral, behavioral and reflective levels to describe how we experience emotion from products. Considering both the objective and cognitive viewpoints, this study divides design metaphor into three levels by juxtaposition: (1) visual level, considering visual elements (e.g., shapes, texture, and color) and the relationship of the elements (e.g., layout, structures and configuration) of products, (2) action level, concerning about the behaviors of either users or products when the products are being operated, (3) image level, referring to users' perceived meanings resulted from the visual level and/or action level in a certain context. Hence, this study supposes that application of the salience imbalance model to metaphorical products should sort features of the target and source at the different levels.

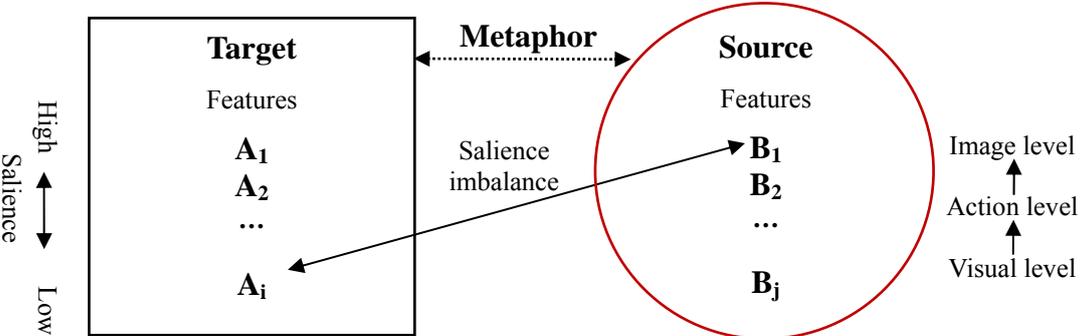


Figure 1. Salience imbalance model with various levels of metaphor.

In Ortony’s salience imbalance theory, four types of similarity between the target and source can be identified: the literal similarity, the non-literal (or metaphorical) similarity, reversed simile, and the anomaly (see Table 1). Given a metaphorical product represented by the pair of a target and a source. According to the theory, if and only if the pair whose target’s features with lower salience (denoted by “a”) is similar to the source’s features with higher salience (denoted by “B”) can be viewed as metaphorical similarity, denoted by “a/B” in this paper. This study supposes that a application of the salience imbalance model to metaphorical products should sort features of the target and source at the different levels. This study supposes such salience imbalance is also applicable to metaphorical products.

Table 1. Four types of similarity between the target and source.

Salience		Features of Target A	
		High: A	Low: a
Features of Source B	High: B	Literal similarity	Non-literal (metaphorical) similarity
	Low: b	Reversed simile	Anomaly

According to domain theory, metaphor is determined by two distances between the target and source. One is the distance between the domains of target and source, which is called between-domain distance in this study. The distance is as farther as better for emotional or poetic effects [17]. For example, a whirlpool from which a drowning man extending his arm to get someone’s help can be analogous to a tinny vortex made by using drink stirrer. The action-level similarity relates to a visual-level similarity; the shape of drink stirrers is designed to be a slim arm. It is evidently the distance between the drowning and drinking is long enough to make a surprising effect.

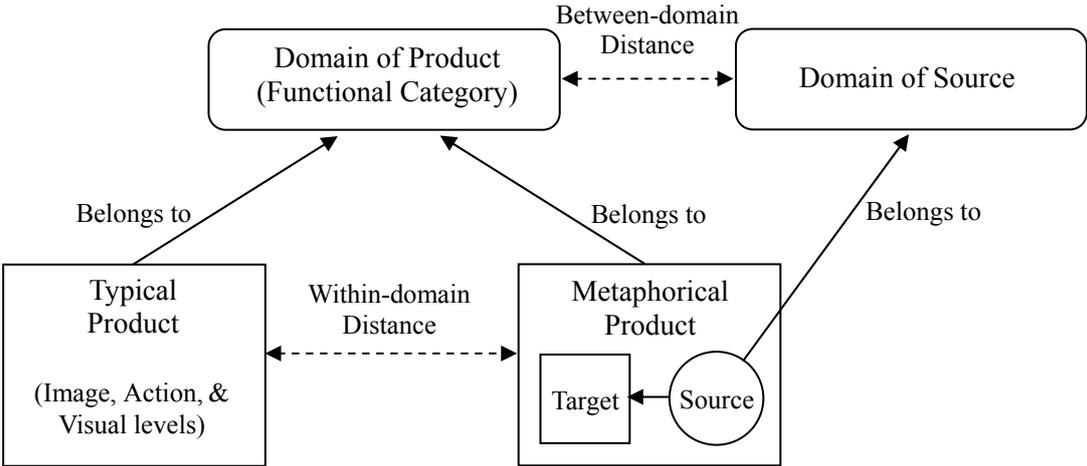


Figure 2. Between-domain and within-domain distances.

The other distance is between the metaphoric product and the typical product (or the dummy product with shortest distances between all other products) within the same domain. This study calls it within-domain distance. Take the above example again. The arm extending from water whirlpool, and the drink stirrer outstretching from surface of drink are similar with each other. For instance, they both share a couple of common features such as

vertical rod-like shape. For a good metaphor, the between-domains distance should be maximized, but the within-domain distance should be minimized. This study supposes such salience imbalance is also applicable to metaphorical products (see Figure 2). For simplicity reason, this study focuses on the visual level and action level for within-domain distance and on the functional category for between-domain distance.

2. Methods

The methods used to decide to which extent salience imbalance theory and domain distance theory are applicable to metaphorical products, this study conducts a series of tests. Stimuli are a collection of five metaphorical lemon squeezers chosen by five senior industrial designers, and a typical lemon squeezer determined by the participants of the tests (see Table 2). The participants consist of sixteen graduate students of industrial design of National Taipei University of Technology, with ages from 23 though 29 year old.

Table 2. Stimuli for testing

					
(T) Typical squeezer	(J) Juicy Salif	(M) Mandarin	(C) Citrus squeezer	(E) Electric squeezer	(L) Lemon squeezer

Table 3. Feature matching of Juicy Salif lemon squeezer.

	Juicy Salif					
	Target		J	Source		
				Spider		
Action	High	Feature Sa	←	Feature Sa	lience	
	Low	1. twister		8.7	1. hunt	8.5
		2. press		8	2. spin	6.5
		3. collect water		7.5	3. move	6
		4. hold		7	4. Jump	5.5
5. stand		6.3		5. Stand	5.5	
Visual	High	1. squeezer head		8.7	1. spider web	8
	Low	2. filter	7.1	2. the body	7	
		3. color	7	3. the legs	6.7	
		4. container	6.7	4. squeezer head	5.7	
		5. the holder	6			

2.1 Testing salience imbalance by feature matching

For simplicity reason, this study focuses on the visual and action-level features. First, the participants are asked to describe the similar object (i.e., the source) of each stimulus. Table 3 demonstrates how the data of feature matching can be obtained. Second, they write down the visual-level features and action-level features of every single source and the typical one (treated as the source). Third, the participants specify the salience for each feature; the most salient features are assessed as the highest weight, and vice versa; the weight ranges from 1 to 9

points). Fourth, they determine the similarity between the features of target and source of each objects, as well as the similarity between creative squeezers and the typical one. Once a participant finds two similar features between the target and source, he or she links them by drawing lines in between. The mean of salience values for each feature can be used to determine the order of salience. If the difference of the orders of two common features is not less than one (≥ 1) for a stimulus, we call it is a product with salience imbalance. By doing so, we can observe salience imbalance in product design.

2.2 Testing domain distance by multi-dimensional scaling

The major source of each creative squeezer can be identified from the results of the above test, and comprise five pairs of the target and source as the stimuli for testing domain distance. To determine the within-domain distance, the participants are asked to measure the distance between each stimuli and the typical squeezer; the distance ranges from 1 to 7. Likewise, to estimate the between-domain distance, the participants measure the distance between the major source of each stimuli and the typical squeezer; the distance also ranges from 1 to 7. Since one of the criteria to choose the stimuli is creativity, the within-domain distances among them should be long to a certain degree.

On the other hand, the classification of product domains in this study is based on functional categories, as previously described. Hence, it seems reasonable to adopt product categories as domains. For instance, the product taxonomy made by Industrial Development Bureau Ministry of Economic Affairs, Taiwan, contains electronic communication, computer and peripheral hardware, fashion life, entertainment, home use, precision instrument and medical health, transportation, and so on. However, the hierarchy of such taxonomy is too complex for this study; e.g., an object that belongs to chair domain can also belong to furniture domain or artwork domain. Moreover, the domain to which the source belongs may not be any product category; e.g., lion as the source to truck. Therefore, we request three senior industrial designers to conclude the single domain of each source for evaluating the between-domain distance. To calculate the within-domain and between-domain distances, this study employs Multi-Dimensional Scaling (MDS).

3. Results

3.1 Salience imbalance

The results of salience imbalance test does not support that salience imbalance theory is applicable to product design. Although the metaphorical similarity (a/B) holds for Citrus squeezer (C), Mandarin (M) and Lemon squeezer (L), yet it does not hold for Electric Citrus squeezer (E) and Juicy Salif (J). Take the feature matching of the stimuli C and E for example. The stimulus C supports salience imbalance theory both at visual and action levels, as all of the lines are drawn at a slant from the higher-salience features of the source to the lower-salience features of the target, as displayed in Tables 4. In contrary, table 5 shows either the stimulus E is a metaphorical product that does not support salience imbalance theory, or in fact E is not a metaphorical product. Nevertheless, in the area of industrial design there is agreement on the metaphoricity and creativity of Juicy Salif Lemon squeezer, though Ortony's salience imbalance theory is not applicable to it. In other words, what industrial designers think of metaphorical products seems not explainable by using salience imbalance theory.

Table 4. Feature matching of Citrus squeezer.

	Citrus squeezer					
	Target		C	Source		
				Astray		
Action	Feature Sa	lience	← →	Feature Sa	lience	
	1. twister	8.7		1. press	8	
	2. press	8		2. collect ash	6.5	
	3. collect water	7.5		3. stand	5	
	4. hold	7		4. decoration	4	
Visual	1. squeezer head	8.7	← →	1. container	7.1	
	2. filter	7.1		2. material	6.7	
	3. color	7				
	4. container	6.7				
	5. the holder	6				

Table 5. Feature matching of Electric Citrus squeezer.

	Electric Citrus squeezer					
	Target		E	Source		
				Egg		
Action	Feature weight		← →	Feature weight		
	1. twister	8.7		1. give birth	8.5	
	2. press	8		2. nutrient	8	
	3. collect water	7.5		3. twister	8	
	4. hold	7		4. shell	8	
Visual	1. squeezer head	8.7	← →	1. egg shell	8.5	
	2. filter	7.1		2. round shape	8.1	
	3. white color	7		3. white color	5.7	
	4. container	6.7				
	5. the holder	6				

Table 6. Four quadrants of metaphorical products with different creativity levels.

Action		n	
		balance	balance
Visual	imbalance	Creativity J, M, E	Novel-form C
	balance	Put-to-other-use L	Common ∅

However, salience imbalance theory has potentials to help us understand the relations between metaphor and creativity. The degrees of creativity for metaphorical products might be described by salience imbalance at action and visual levels, as represented in four quadrants (see Table 6). If the salience values of common features of the target and source of a product are not equal to each other, then we call it a metaphorical product with salience imbalance (i.e., either a/B or A/b, but neither A/B nor a/b). It is reasonable to use the four quadrants to divide different levels of creativity. If a metaphorical product represents salience imbalance both at action and

visual levels, it falls into “Creativity” quadrant. If the product represents salience imbalance only at visual level, it falls into “Novel-form” quadrant. If the product renders salience imbalance only at action level, it falls into “Put-to-other-uses” quadrant. If the product does not fall into any one of these quadrants, we put it into “Common” quadrant. According to the classification and the observations in the test, Juicy Salif, Mandarin, and Electric-citrus-squeezer belong to creativity quadrant. Citrus squeezer falls into novel-form quadrant, whereas Lemon squeezer the Common quadrant.

3.2 Domain distance

By using MDS, the between-domain distances are calculated and represented in perceptual map (see Figure 3). The length order of the distance between the domain of (normal) lemon squeezers and the domain of the source of each stimulus is both Figure and Spider, Egg, Ashtray, and Grill (denoted by $f=s > e > a > g$). The between-domain distances of Spider and Egg are greater than the mean ($= 1.873$), while that of Ashtray and Grill are less than the mean. Still, the within-domain distances calculated with MDS show that the length order of the distance between the typical (or normal) lemon squeezer and each stimulus is both Mandarin and Juicy Salif, Electric Citrus Squeezer, Citrus Squeezer, and Lemon Squeezer (denoted by $M=J > E > C > L$). Juicy Salif can be seen as the most creative one, for its longest between-domain distance and the shortest within-domain distance.

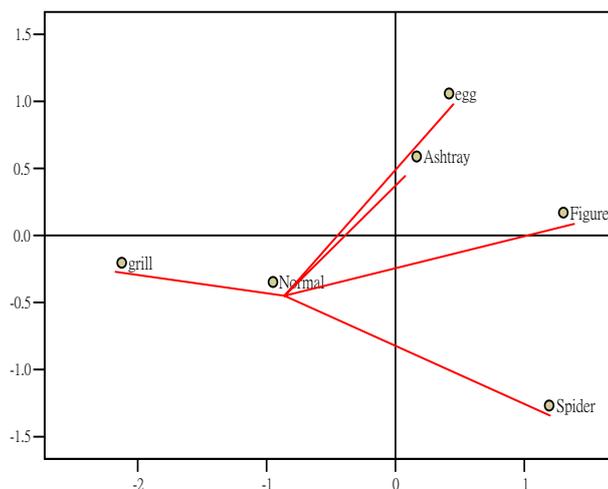


Figure 3. Between-domain distances represented in perceptual map by MDS

4. Discussions

4.1 Salience imbalance

It is very helpful to describe a metaphor product as a pair of the target and source which share some common features at visual, action, and image levels. Major finding of this test is that salience imbalance theory (specifically) is not completely explainable for metaphorical products, because the imbalance can be either A/b or a/B. Other findings include that a metaphor product with salience imbalance at both visual and action levels is subjective to creative design. A metaphor product with salience imbalance at either visual or action levels, but not both, is subjective to novel-form or put-to-other-uses design, respectively.

4.2 Domain Distances

Results of domain distance test indicate that Juicy Salif is the stimulus with the highest metaphoricity, because of its longer between-domain distance than average and the shortest within-domain distance. This finding is consistent with the observation of salience imbalance test. Since Juicy Salif is widely thought a highly creative product in the area of industrial design, the relationship between metaphoricity and creativity is worth further studying.

4.3 Metaphoricity and Creativity

The side-product of salience imbalance analysis is the four-quadrant framework to re-classify metaphorical products into various types of creativity, namely common quadrant (i.e., the typical product), put-to-other-uses quadrant (relating the source with salience imbalance at action level to the target), novel-form quadrant (relating the source with salience imbalance at visual level to the target), and creativity quadrant (relating the source with salience imbalance at both visual and action level to the target). The framework has potential to explore relationships between metaphor and creativity.

4.4 Summary

The applications of Andrew Ortony's salience imbalance theory and Ellen Winner's domain distance theory to metaphoric products has been tested. The originality of this paper is two-fold. First, we divide the features of targets and sources in a metaphorical product into visual, action, and image levels. Second, we propose a four-quadrant framework to sort the metaphorical products with different creativity levels. Testing salience imbalance by feature matching, and estimating domain distances by MDS, this study argues that salience imbalance theory is not completely explainable for metaphorical products, and there might exist positive relationship between metaphoricity and creativity.

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