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Less for more, but how & why? – Number of elements as key determinant of visual complexity

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Although designers aim at “less for more” when developing a product, they struggle with how to achieve simplicity and why making a product simple improves the commercial value of the product. To answer the two questions, we performed one experimental study. In the study, we searched for which of the six different types of lowering visual complexity is effective and examined whether authenticity mediates the effect of visual complexity on commercial value. Results show that three out of six types of lowering visual complexity (e.g., irregularity of arrangement, amount of material, incongruity) deemed to be more commercial value. Results also show that decreasing the amount of material is the only way to enhance authenticity, which in turn increases the commercial value of the product.

Keywords: Visual complexity, Authenticity, Commercial value

1 Introduction

“Less for more” is a popular saying among designers. This design tendency is also evident in the principles and philosophies of influential designers. It led the “less is more” movement in architecture characterized by the works of Mies van der Rohe. It introduced “white space” in advertisement originated from a famously simple IBM block logo designed by Paul Rand (Pracejus, Olsen, Guinn, Olsen, & Guinn, 2006). This tendency also resulted in the commercial success of the consumer electronics designed by Dieter Rams in Braun, who introduced “good design is as little design as possible.” (Lovell, 2011). He argued that a product is beautiful when it has a few basic geometric shapes with non-fussy colors. His approach later inspired Jonathan Ive, who has designed a wide variety of highly popular electronic products at Apple.

Designers have a consensus about what is simple. The common design style ‘simple’ corresponds to prior research that has demonstrated a general preference towards objects and designs that are symmetric, unified, and have low complexity (Berlyne, 1970; Hekkert & Leder, 2008; Hutchinson, 1998). Complexity is a design attribute that is used by designers which are opposite (and therefore correlated) to the attribute simplicity (Blijlevens, Creusen, & Schoormans, 2009).

However, package designers often struggle with how to achieve simplicity and are not fully informed about why making a product simple improves commercial value in package design.

For instance, simplicity was identified as the appearance attributes that consumers in general use to distinguish between different product appearances (Blijlevens et al., 2009). Therefore, simplicity is related to a product's competitiveness, which can lead to commercial value. Most designers would agree that simplicity is a virtue in design. However, the nature of this simplicity has yet to be clearly elucidated (Shelley, 2015). Also, most approaches and methods aimed at reducing complexity in some way, but reducing design complexity is not an easy task (Stolterman, 2008).

Therefore, this research has two purposes. Note that answering each purpose benefit different groups of people. First, we aim to answer "How can we decrease visual complexity?" Answering this question will benefit designers. In the past, designers have achieved simplicity in many different ways. Some have done decreasing the amount of embellishments in fashion (Cox & Cox, 2002) and others have done simplifying shapes in car design (Lee, Jung, & Chu, 2015). In general, practical knowledge about decreasing visual complexity in package design has not been established.

Second, we aim to answer "Why does decreasing visual complexity of a package design improve the commercial value of the product?" Answering this question will benefit managers. In the past, studies regarding how visual complexity affects commercial value of the product were scarce. Therefore, practical knowledge about decreasing visual complexity needs in-depth research.

In the prior literature, decreasing visual complexity has been found to be advantageous in processing information (Reber & Schwarz, 2004). This metacognitive advantage is believed to benefit commercial value, suggesting that decreasing visual complexity is rather a non-cognitive advantage. In this research, we argue there is another cognitive reason why doing so increases commercial value.

2 Theory

2.1 Visual complexity

Visual complexity is narrowly defined as the amount of detail or intricacy of lines in the picture (Snodgrass & Vanderwart, 1980). A broader definition of visual complexity comes from Berlyne, an experimental psychologist who investigates complexity, arousal, and preference. According to his research (1958), there are six different types (ways) of increasing or decreasing visual complexity.

- (VC_A) *Irregularity of arrangement*: the elements are arranged in an irregular geometrical pattern and irregularly scattered (Berlyne, 1958). For instance, an image containing an irregular geometrical pattern is visually more complex than an image with a regular geometric al pattern.
- (VC_B) *Amount of material*: the amount of elements is arranged as independent visual elements. For instance, an image containing more lines is visually more complex than an image with fewer lines (Peckham, 1966).
- (VC_C) *Heterogeneity of elements*: the same number of different elements in a similar spatial arrangement (Berlyne, 1958). For instance, when a picture consists of a circle, triangle, and square, it is visually more complex than a picture with multiple circles only.
- (VC_D) *Irregularity of shape*: is the nonsymmetrical shape arrangement. For instance, nonsymmetrical shape is more complex than regularity of shape, regularity of contour

and symmetry. Regularity of contour and symmetry imply similarity of parts and predictability of changes in curvature, all of which means high redundancy (Berlyne, 1958)

- (VC_E) *Incongruity*: an unusual arrangement as a picture of a normal animal and a picture of an incongruous animal, i.e., one with parts appropriate to different species or with three heads (Berlyne, 1958). These are closely related to Gestalt characteristics of a product. For instance, when a picture shows a bird's head with a cat's body, it is visually more complex than a picture of either a bird or a cat (Berlyne, Craw, Salapatek, & Lewis, 1963).
- (VC_F) *Incongruous juxtaposition:* this arrangement bears the same material but with the halves of the two objects incongruously juxtaposed (Berlyne, 1958). For instance, when the halves of flowers and the halves of airplane incongruously juxtaposed, it is visually more complex than when either the flowers or the airplanes are placed in an isolated way.

Much prior research has shown that visual complexity influences the psychology of people. When it increases, people increase their attention, interest, and looking time (Eisenman, 1966; Geissler, Zinkhan, & Watson, 2006; Morrison & Dainoff, 1972; Peckham, 1966). For instance, consumers respond more favorably when they watch moderately complex websites than simple or highly complex websites (Geissler et al., 2006). Consumers look at visually complex advertising for longer periods of time (Morrison & Dainoff, 1972). Indeed, visual complexity critically influences people's first impressions, emotions, and aesthetic preferences concerning the stimuli (Berlyne, 1970; Cox & Cox, 2002). For instance, (Cox & Cox, 2002) showed consumers' preferences for visually complex product designs increase with repeated exposures whereas their preferences for visually simple product designs do not. Berlyne (1971) claims that the visual complexity of a product determines its arousal potential, which determines people's arousal response to it. Especially minimalistic package design will positively affect the product's perceived quality and premium perceptions. An example comes from the Sourcy Pure Blue bottle. This bottle is minimalistic and thus premium because it has a basic shape and does not feature any superfluous visuals or text. In contrast, the Aquapax package and the complex shape of Tŷ Nant associated the extensive illustrations and considered less premium water brands (Mugge, Massink, Hultink, & Berg-, 2015).

Differently from what has been discussed in the prior research, based partially on Geissler et al. (2006), we propose that decreasing visual complexity of a product increases the commercial value of the product.

- H1: If the visual complexity of a product decreases, its commercial value will increase.

2.2 Authenticity

'Authentic' implies that the product design refers to a historical, original source, and has been created within that particular context (Snelders, Mugge, & Huinink, 2019). Authenticity is widely acknowledged as a critical dimension for consumers that can be assessed along dimensions such as product styling, connections to a particular location, and firm values (Newman & Dhar, 2014). For example, the Gem paper clip - firstly introduced in the early

1870s - is nowadays considered a classic because it is the oldest and the most practical paper clip model, setting the world standard from the very beginning (Snelders et al., 2019).

Authenticity is an important variable in contemporary marketing (Belk, Costa, & Costa, 1998; Holt, 1997; Kozinets, 2001) and has been garnering increasing attention in the literature (Ilicic & Webster, 2014). As a result, different definitions referring to different types of authenticity have emerged (Valsesia, Nunes, & Ordanini, 2016).

Interestingly, authenticity widely appears in the marketing literature, but only a few design researchers have investigated it. For instance, in craft design, the knowledge of the touch of the human hand makes the product more valuable than a machine-made one because of its authenticity (Kälviäinen, 2000). In textile design, It is considered to render textile design relevant and is a determinant of the level of its craftsmanship (Valentine, Ballie, Robertson, Bletcher, & Stevenson, 2017).

In the present research, we claim that when the visual complexity of a product decreases, the authenticity of the product increases. Our claim is supported by two cases. First, consider the introduction of the original Bondi iMac in 1998. The new iMac was to be the design that re-introduced the public to Apple design, as Steve Jobs envisioned it. It turned out, however, that the design of the Bondi iMac contained an unwelcome surprise for him, in the form of a CD drive with a loading tray (Shelley, 2015). For the user, a CD drive with a tray is more complex than a CD drive with a slot. The tray has a button that the user must push in order to unlatch it. Once the tray is unlatched, the user pulls it out, places a CD in it and pushes it to close. By contrast, the CD slot has no tray and no button. From the user's perspective, it is simply a hole into which CDs may be pushed and from which they may be pulled upon ejection. So, the slot drive is more minimal and thus better than the tray (Shelley, 2015). Second, for a company like Bang & Olufsen, heritage and craftsmanship are vital parts of the brand – even such traits are concepts often perceived concerning authenticity (Sommer, 2012). In order to enhance the authenticity, Bang & Olufsen's focus on simplicity and style as a brand is something that can be seen in everything they do. While B&O believes that beauty is important alongside function, they do not over-work their designs. Instead, they take a minimalist approach (Hodgson, 2017).

In the prior research decreasing visual complexity increases processing fluency (Reber & Schwarz, 2004). The authors proposed that processing fluency, the speed, and ease at which one processes information, was positively related to people's aesthetic judgment of objects. When visual complexity increases, the salience of the source of perceptual fluency decreases, enhancing the misattribution of fluency to beauty. However, further increases in complexity will eventually reduce processing fluency, leading to a decrease in perceived beauty (Reber & Schwarz, 2004). As a result, a decrease in visual complexity allows for easy processing of visual information, which results in high preference.

In contrast, we propose that visual complexity influences the authenticity of the product, which enhances its commercial value. Put simply, differently from the prior research suggesting that people like a visually simple product because visual simplicity relieves the cognitive burden; we argue that people like a visually simple product because, they think, it is perceived to be authentic.

- H2: Authenticity mediates the relationship between visual complexity and commercial value.

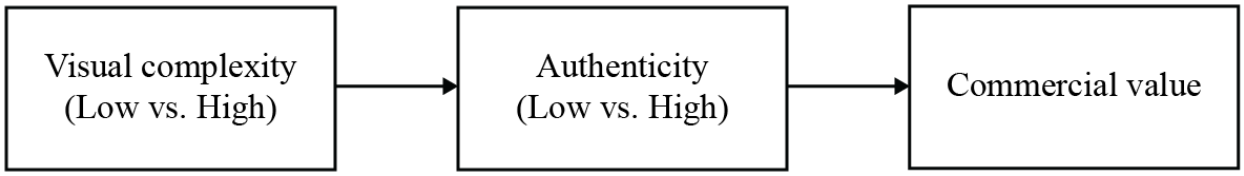


Figure 1: Research framework

3 Study

3.1 Objective

We tested hypotheses 1 and 2. We decreased the visual complexity of an eyeshadow palette package design in multiple ways to examine which way increases the commercial value of the product (H1). We also examined whether decreasing visual complexity of an eyeshadow palette package design increases its commercial value through its enhanced authenticity (H2).

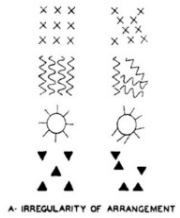
3.2 Design

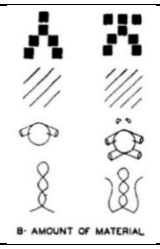
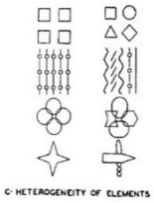
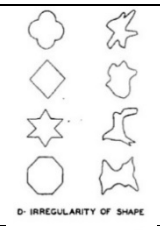
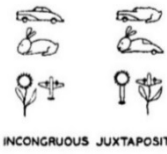
In this study, we employed a 7 (0 vs. VC_A vs. VC_B vs. VC_C vs. VC_D vs. VC_E vs. VC_F) between-subjects design.

3.3 Stimuli

We selected an eyeshadow palette as a baseline stimulus and then manipulated its visual complexity in six different ways. The product of the Korean cosmetic company ARITAUM - eye shadow palette (=0) - was chosen because it met all the conditions of visual complexity (Berlyne, 1958), and also presents several visual elements. Furthermore, if Korean cosmetics are used as stimulus, it can be applied directly to the sensitive Korean cosmetics market. A trained designer created digital 2D models of eyeshadow palette package and manipulated the shape of the stimuli following the six different types of lower visual complexity. The brand name was removed to eliminate the brand effect (see Table 1).

Table 1: Six types, manipulations, and stimuli of visual complexity

Types	Type of visual complexity based on Berlyne (1958)	Manipulation	Stimuli
0	-	-	
VC_A		Compared with the control, the manipulated product presents the elements watermelon slices and seeds arranged in a regular geometrical pattern	

VC_B		Compared with the control, the manipulated product removed some watermelon slices and seeds at once	
VC_C		Compared with the control, the manipulated product presents the same number of identical elements (watermelon slices and seeds) in a similar spatial arrangement	
VC_D		Compared with the control, the manipulated product presents watermelon slices and seeds with regularity of shape, regularity of contour and symmetry.	
VC_E		Compared with the control, the manipulated product presents a congruous picture combining watermelon slices and seeds.	
VC_F		Compared with the control, the manipulated product presents watermelon slices and seeds placed in an isolated way	

3.4 Procedure

This experiment was conducted for 14 days from January 10 to January 24, 2019, at a university located in Seoul, Korea. We recruited 254 female students. Since male students rarely use eye shadows, we avoid them. We approached them using SNS advertisements.

We used Qualtrics to design an online questionnaire and collect responses. We wrote questions in both English and Korean to prevent misunderstanding. Participants received one of the seven questionnaires randomly (0 vs. VC_A vs. VC_B vs. VC_C vs. VC_D vs. VC_E vs. VC_F). Note that the specifications of the eye shadow palette were provided equally to the whole participants.

3.5 Measure

To test whether our manipulations were successful, we measured perceived complexity of the product as well as asked a specific question for each product. First, perceived complexity was measured by two questions on 7-point scales anchored by complicated-simple (1 =

complicated, 7 = simple) and simple-complex (reverse coded) (1 = simple, 7 = complex) (Cox & Cox, 2002): '1. How simple does this product look like?; 2. How complex does this product look like?.' Second, we asked a specific question in each condition. After realizing the questionnaire (Cox, 2002) was insufficient to measure the six conditions, we developed based on Berlyne (1958). It was measured on 7-point semantic differential scales anchored by few-a lot (1 = few, 7 = a lot), regular-irregular (1 = regular, 7 = irregular), homogeneous-heterogeneous (1 = homogeneous, 7 = heterogeneous), and symmetrical-asymmetrical (1 = symmetrical, 7 = a symmetrical) (Peckham, 1966): '1. How many design elements does this product have?; 2. Are the design elements of this product irregular (not even or balanced in shape or arrangement)?; 3. Are the design elements of this product heterogeneous (diverse in character or content)?; 4. Are the design elements of this product asymmetrical (having parts or aspects which are not equal or equivalent)?' The coefficient alpha for the measurement scale was .78.

The authenticity was measured by one question on one 9-point semantic differential scale anchored by inauthentic-authentic (1 = inauthentic, 9 = authentic) (Newman & Dhar, 2014): '1. When you think about what it means to be truly authentic product, you would have to say that this product is…'

Finally, the commercial value consists of the sum of purchase intention and willingness to pay. Purchase intention was measured by three questions on 7-point scales (1 = strongly disagree, 7 = strongly agree) (Putrevu & Lord, 2014): '1. It is very likely that I will buy this product; 2. I will purchase this product the next time I need a product; 3. I will definitely try this product.' Regarding willingness to pay, it was measured by two questions on a 9-point scale anchored (1 = would not pay a premium, 9 = would pay a premium) (Newman & Dhar, 2014): '1. How much would you be willing to pay for this particular product relative to the average product?; 2. How likely would you be to purchase this particular product?' The coefficient alpha for both measurement scales was .87.

4 Results

4.1 Manipulation check

Multiple independent t-tests were performed in order to test whether visual complexity was manipulated as intended. Data suggest that five products (VC_A, VC_B, VC_C, VC_D, and VC_E) were successfully manipulated and one product (VC_F) failed to be manipulated. More specifically, participants responded that when the product has a regular arrangement (M_0=4.640 vs M_{vcA}=2.707, t(52)=4.011, p<0.01), when the product has fewer materials (M_0=4.640 vs M_{vcB}=2.260, t(48)=5.260, p<0.01), when the product has homogeneous elements (M_0=4.640 vs M_{vcC}=2.760, t(48)=3.788, p<0.01), when the product has a regularity shape (M_0=4.640 vs M_{vcD} =2.518, t(51)=4.479, p<0.01), and when the product has a congruent element (M_0=4.640 vs M_{vcE} =2.900, t(48)=3.801, p<0.01), it was considered visually less complex than the original product which was not manipulated. However, when the visual elements are congruously juxtaposed, doing so failed to decrease perceived visual complexity.

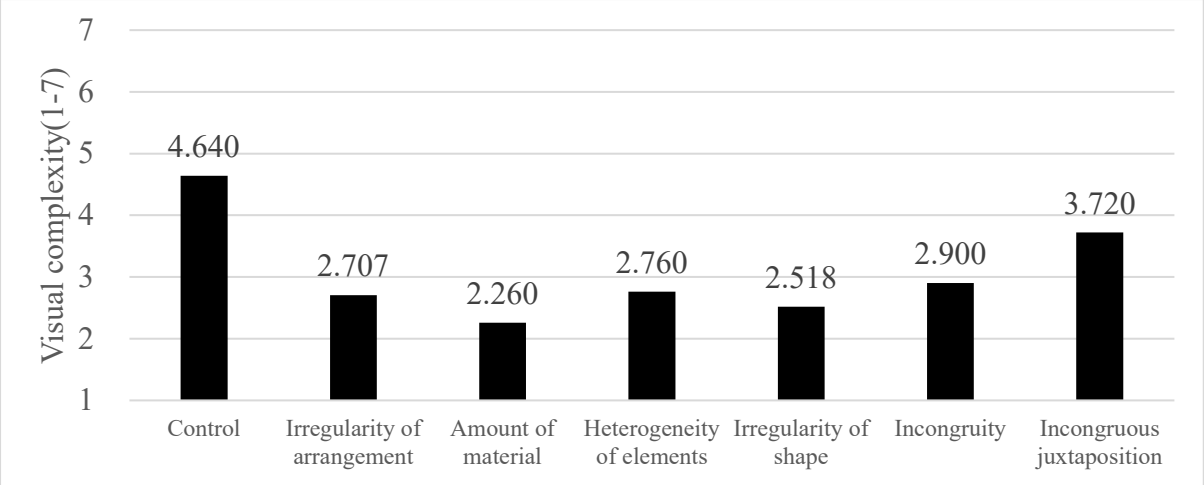


Figure 2: Mean scores of visual complexity

4.2 Commercial value

Independent t-tests were performed in order to test H1. Data suggest that three products (VC_A, VC_B, and VC_E) were significantly higher than control. More specifically, participants responded that when the product has a regular arrangement (M_0 =2.952 vs. M_{vcA} = 4.427, t(52) = 4.351, p<0.01), when the product has fewer materials (M_0=2.952 vs. M_{vcB}= 4.440, t(48)= 4.430, p<0.01), when the product has a congruent element (M_0=2.952 vs M_{vcE} =3.984, t(48)= 3.296, p<0.05), and when there are three types of lower visual complexity (VC_A, VC_B, and VC_E) it increased the commercial value of the product whereas the other three types (VC_C, VC_D, and $VC_{F)}$ failed to increase its commercial value.

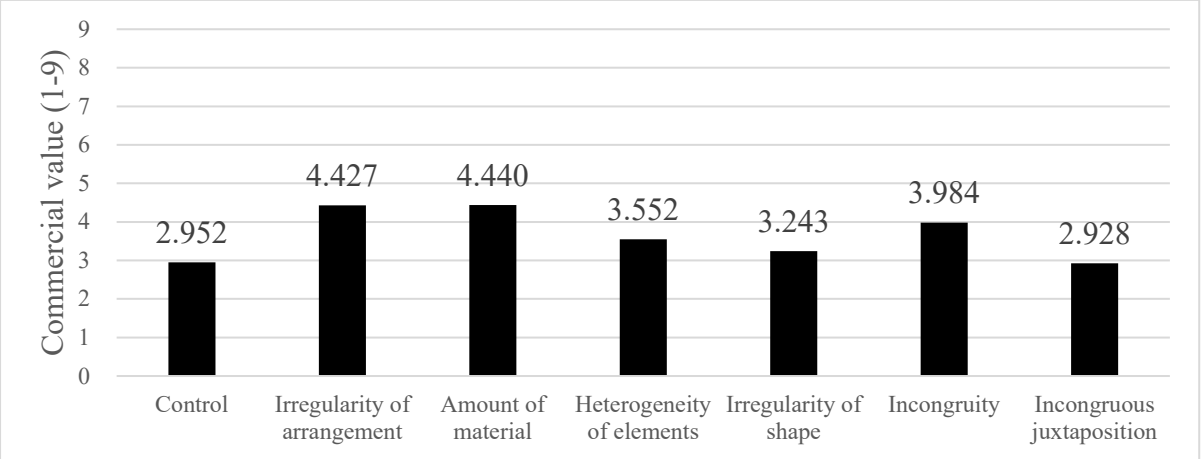


Figure 3: Mean scores of commercial value

4.3 Authenticity

Independent t-tests were performed in order to compare the difference in the mean scores of authenticity. Data suggest that three products (VC_A, VC_B, VC_E) were significantly higher than control. More specifically, participants responded that when the product has a regular arrangement (M_0 = 3.800 vs. M_{vcA} = 5.172, t(52) = 2.959, p<0.01), when the product has fewer materials (M_0=3.800 vs. M_{vcB}=5.240, t(52)=2.586, p<0.01), and when the product has a congruent element (M_0=3.800 vs. M_{vcE} =4.880, t(48)=2.247, p<0.05), the three types of lower visual complexity (VC_A, VC_B, and VC_E) increased the authenticity of the product whereas the other three types (VC_C, VC_D, and $VC_{F)}$ failed to increase its authenticity.

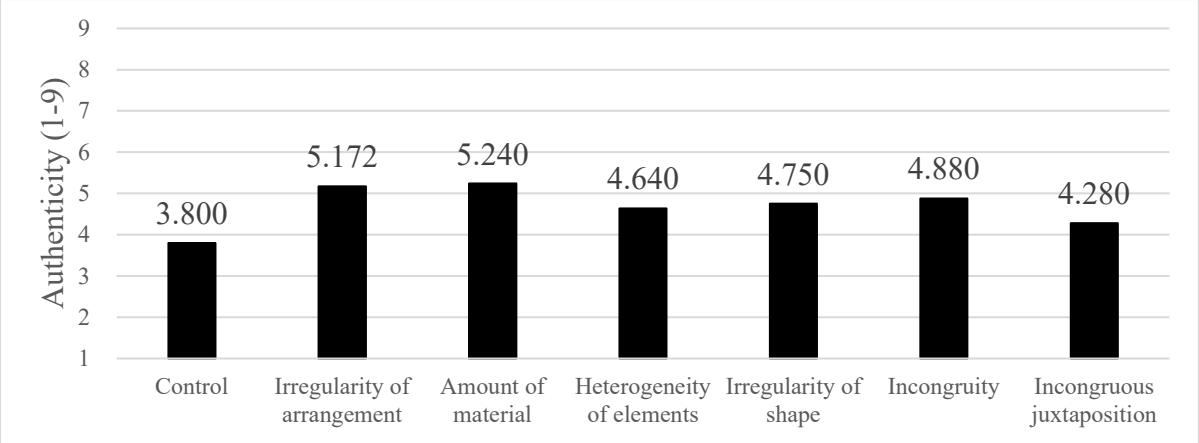


Figure 4: Mean scores of authenticity

4.4 Mediation analysis

To test H2, data were analyzed using Hayes' (2013) PROCESS Model 4 for simple mediation with 5,000 bootstrap samples and a bias-corrected 95% confidence interval. The analyses were performed for commercial value as the dependent variable, with visual complexity as the independent variable and authenticity as the mediation.

As a result of the analysis, we confirmed that only the VC_B is mediated through authenticity. It can be judged statistically significant when 0 does not enter the confidence interval at 95% level. The direct effect of visual complexity on commercial value was -.382, which was not statistically significant. The indirect effect of visual complexity on commercial value was -.238, which is statistically significant. The effect on the visual complexity to commercial value is fully mediated by the authenticity (see Table 2).

Table 2: Total effect, direct effect, and indirect effect of visual complexity on commercial value.

Total effect visual complexity on commercial value					
effect	SE	LLCI	ULCI	t	p
-.619	.230	-1.096	-.142	2.685	.013*
Direct effect visual complexity on commercial value					
effect	SE	LLCI	ULCI	t	p
-.382	.185	-.766	.003	2.060	.051
Indirect effect visual complexity on commercial value					
effect	Boot SE	Boot LLCI	Boot ULCI		
-.238	.130	-.548	-.032		

5 Findings

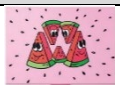
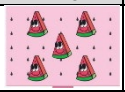
Our experiment produced in total three findings. First, decreasing visual complexity differently results in different degrees of commercial impacts. For instance, five types of lower visual complexity (VC_A, VC_B, VC_C, VC_D, and VC_E) could decrease the perceived visual complexity whereas one type failed to do so (see Table 3).

Second, the effect of visual complexity on commercial value depended on the type of visual complexity. For instance, three types of lower visual complexity (VC_A, VC_B, and VC_E) increased the commercial value of the product whereas the other three types (VC_C, VC_D, and $VC_{F)}$ failed to increase its commercial value. Regarding the three types of lower visual complexity (VC_A, VC_B, and VC_E), because of their simple design, we conjecture people are more familiar than those other three types (VC_C, VC_D, and VC_F). This implies that three types

of lower visual complexity (VC_A, VC_B, and VC_E) can improve the commercial value differently.

Third, the results of the mediating effect of authenticity provide important insights into the role of authenticity in the effect of visual complexity on commercial value. They show that VC_B is the only way to decrease visual complexity, which increases commercial value through enhanced authenticity

Table 3: Statistically significant visual complexity type by variable

Type		Control	VC_A	VC_B	VC_C	VC_D	VC_E	VC_F
Stimuli								
IV	Visual complexity	4.640	2.707**	2.260**	2.760**	2.518**	2.900**	3.720
DV	Commercial value	2.952	4.427**	4.440**	3.552	3.243	3.984*	2.928
MeV	Authenticity	3.800	5.172**	5.240**	4.640	4.750	4.880*	4.280

*p< 0.05 **p< 0.01

6 Discussion

In conclusion, this study has academic significance showing that visual complexity (high vs. low) affects commercial value through authenticity, which has not been actively discussed in the existing visual complexity studies. Although authenticity appears in some marketing research, it is interesting that in this study we have found that visual complexity can affect authenticity.

The results of this study support our hypotheses. As expected, package design in the high level of visual complexity is less commercial than package design in the low level of visual complexity (H1). Moreover, a mediation analysis shows that this effect of visual complexity on commercial value is mediated by authenticity (H2).

7 Theoretical implications

In this study, we showed that visual complexity influences the authenticity of the product, which enhances its commercial value. Our findings differ from the prior research arguing that aesthetic pleasure depends on the perceivers' processing dynamics (Reber et al., 2004). Prior research suggests that cognitive load caused by a lot of information leads to a decrease in processing fluency (Reber & Schwarz, 2004). High cognitive load and low processing fluency decrease preferences for products. Differently from the prior research suggesting that people like a visually simple product because it relieves cognitive burden, we demonstrated that people like a visually simple product (VC_B - fewer materials) because it is perceived to be authentic. In summary (Figure 5), prior studies suggest a metacognitive mechanism in which lowered visual complexity positively influences observers' process fluency. But this study suggests a cognitive mechanism that lowers visual complexity, positively influences observers' authenticity.

This research is meaningful because it has further proposed cognitive mechanisms in relation to product preferences. In other words, although prior studies say that the preference for products depends on the observer's processing fluency, the product's authenticity is also academically meaningful, and it can be considered an important mediator.

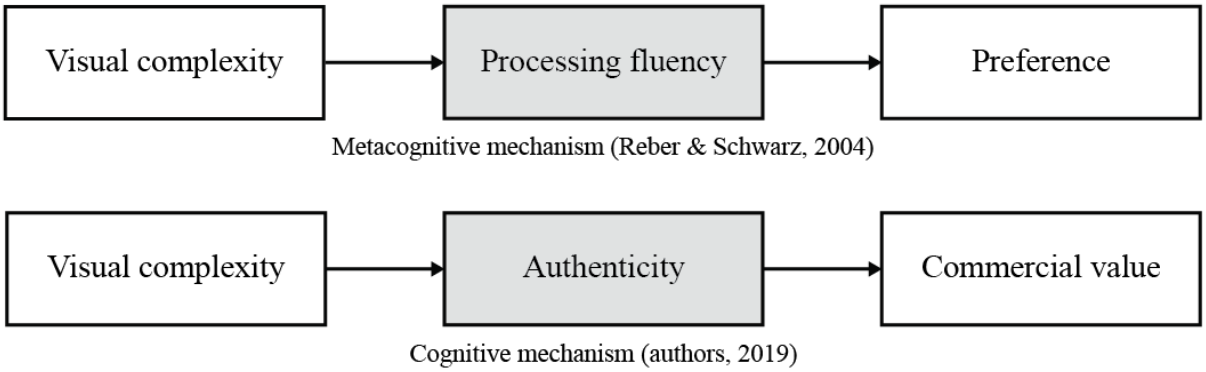


Figure 5: Compared metacognitive and cognitive mechanisms

8 Practical implications

Our findings have practical implications for answering how and why decreasing visual complexity.

First, this research provides practical knowledge helping designers in developing a visual design strategy for their products. This study verified that consumers respond differently to visual complexity in a package design depending on their types. This implies that all types of lower visual complexity can be appealing to consumers differently, and the six types of lower visual complexity (Berlyne, 1958) should be applied differently depending on the circumstances.

Designers have a consensus about what is simple. But they rely on their senses for their simple designs. This research suggests six different types of lower visual complexity and how to decrease it, and quantitatively provides them with what is effective. Therefore, designers can use separately effective methods for decreasing visual complexity.

For instance, designers and managers need to pay attention to irregular arrangement, amount of material and incongruity to improve commercial value. Furthermore, this study verified that consumers respond differently to visual complexity in a package design depending on their level of authenticity. Therefore, designers need to consider the importance of authenticity and to do this; they consider reducing the amount of visual material.

Second, this study provides practical knowledge helping managers in developing a marketing strategy. In this study, we have extracted an effective way of using lower visual complexity. Considering this, managers need to attract consumers' attention by using appropriate visual complexity based on irregular arrangement, amount of material, and incongruity. Thereby, drawing an arousal response from consumers and encouraging them to experience excitement and to focus on the product. Furthermore, this study verified that consumers respond differently to visual complexity in a cosmetic package design depending on their level of authenticity. Those with authenticity - cosmetic package design with low visual complexity - were found to have greater commercial value than those with high visual complexity.

9 Research limitations

This study has several limitations, but if we overcome these limitations step by step, we can expect interesting future research.

First, cosmetics vary in types, but in this study, it was difficult to deal with various characteristics of cosmetics by limiting experimental stimulus to ARITAUM's eyeshadow pallet. For example, even if it is the same cosmetic line, the commercial value can be affected differently depending on the product type. In future research, we will need to make use of a variety of product line to make more comprehensive research.

Second, the results of this study have demographic limitations. The study participants were limited to female students. Because male students rarely use eye shadows, we avoid male participants. If we conduct further research on more diverse groups, we can draw more generalized conclusions theoretically and practically.

Third, this study is expected to be an important variable in how sensitive it is the design of a product. In other words, if participants have a major in design or related people, they can increase their authenticity because it is accepted positively when they see a simple product. In additional experiments, participants should review how familiar they are with the field of design.

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