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# Thinking Skills and Creativity

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## Decomposing the influences of aesthetic experience processes on creativity learning through various consciousness interventions

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### ABSTRACT

Aesthetic experience (AE) and creativity overlap in cognitive processes; the conscious practice of AE focused on everyday designed products can be an effective way to enhance creativity. To better understand the effects of such conscious practice, we designed one control intervention with free product observation and four interventions corresponding to four product-based AE processes, by which we explored what types of conscious practice would best facilitate the learning of creativity. Additionally, the moderation effect of everyday aesthetic experience in designed products was examined. One hundred and eighty college students were randomly assigned to five intervention groups: Control group (C), Perceptual analysis (E1), Life-experience association (E2), Functional analysis (E3), or Aesthetic-emotion evocation (E4). The intervention stimuli were 50 photos of everyday designed products, and the creativity was measured by the Product-based Figural Creativity Test. The results revealed that engaging the participants in conscious AE practices, especially those that contribute to the association between imaginary narratives and the participants' life experiences (E4) or that enhance analytical thinking on valuableness of the product (E3), can best improve college students' creativity. Besides, the personal trait of everyday AE interacted with the interventions and influenced the participants' creativity improvement, suggesting that providing scaffolding in accordance with personality traits can magnify the effects of learning creativity. To conclude, this study theorizes and examines the link between varied AE-based practices and the performance of creativity as well as the moderation role of everyday AE in such learning. The findings provide valuable insight for designing effective AE-based interventions for enhancing AE and creativity.

### 1. Introduction

Creativity involves the development of a novel product or problem solution that is original and valuable to the individual and/or the larger social group (Hennessey & Amabile, 2010; Valgeirsdottir & Onarheim, 2017; Yeh, 2017). The World Economic Forum (2018) declared creativity a top skill required by employers. Cultivating young people's creativity is more imperative than ever

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because it has increasingly emerged as the competence of the future.

Past fMRI studies (Beaty, Benedek, Kaufman, & Silvia, 2015; Beaty, Benedek, Silvia, & Schacter, 2016) have also found that creativity involves the interplay of the default mode network and the executive cognitive network. While the executive cognitive network relates to controlled memory retrieval, executive processes, and idea evaluation, the default mode network is associated with internally-directed attention, spontaneous cognition, and idea generation (Di Domenico & Ryan, 2017). Along the same lines, a recent fMRI study found that product-based creative thinking involves dynamic interactions of bottom-up and top-down thinking, and top-down thinking involves the executive cognitive network and consciousness (Yeh, Hsu, & Rega, 2019). In behavioral research, it is also declared that creative processes involve information retrieval, association, integration, executive selection, and decision-making (Amabile, 1996; Yeh, Lai, & Lin, 2016); these cognitive processes, in a great part, involve conscious processes. Accordingly, enhancing these cognitive processes with a more conscious approach may contribute to a greater performance of creativity.

It has been suggested that aesthetics is an essential component of creative products, and conscious practice of aesthetic experience (AE) focused on everyday designed products can be an effective way to enhance creativity (Yeh, Rega, & Chen, 2019). This study, therefore, proposed an AE-based approach that integrates the key elements of AE and creativity pertaining to product design, by which five interventions were developed and their effectiveness was examined. In addition, it has been found that personal traits carry great influences on AE (Boutoleau-Brettonnière et al., 2016; Krajewska & Waligórska, 2015). AE and creativity, in essence, are part of our lives in modern society; they should be practiced and cultivated in the context of everyday life. Accordingly, this study examined whether the individual trait of everyday AE would interact with the interventions and, further, influence the performance of creativity about product design.

## 2. Related work

### 2.1. Aesthetic experience, consciousness, and creativity

“Aesthetics” has various meanings, from sensory experiences relating to arts and everyday objects to a wide range of conceptual categories, such as form and expression, symbolism and imagery, beauty, taste, and feelings (Hekkert, 2006). In psychology, AE is defined as a process involving interactions among several cognitive and emotional processes; two major outcomes are aesthetic judgment and aesthetic emotion (Leder, Belke, Oeberst, & Augustin, 2004; Leder, 2013; Nadal & Skov, 2013; Zeki, Romaya, Benincasa, & Atiyah, 2014). In the same vein, Savoie (2017) declared that AE is both intuitive and critical; making an aesthetic judgment requires a curious mind and special attentiveness. Such experience involves the implementation of perceptual abilities and imagination.

The close relationship between AE and creativity is supported by both theories and empirical studies (e.g., An & Youn, 2018; Shokorova, Grechneva, & Bochkovskay, 2016). Creativity involves the discovery, understanding, development, and expression of orderly relationships (Heilman, 2016). AE cognitive processes and abilities, such as curiosity, imagination, aesthetic sense, innovative thinking, emotion, and evaluative judgment (Brattico & Pearce, 2013; Mahgoub, 2016; Savoie, 2017; Stojilović, 2017; Zeki et al., 2014), are critical to these creative processes. Empirical studies of art educational research also support the relationship between AE and creativity. Sowden, Clements, Redlich, and Lewis (2015) found that improvisational activities in art classes contributed to the development of various thinking and creativity skills among primary school children. In the same vein, it has been found that participation in art education or aesthetic education increases aesthetic sense, innovative thinking, and creativity (Mahgoub, 2016; Sowden et al., 2015; Styhre & Eriksson, 2008). These findings suggest that AE experience is inspirational to one’s creative thinking and that AE interventions can lead to enhancement of aesthetic ability and creativity.

To date, most AE research has focused on fine arts (Liu, Lughofer, & Zeng, 2015); few studies have evaluated mundane arts, such as designed products that are commonly seen or used in everyday life. Recently, Yeh and Peng, (2019) proposed an AE model about everyday designed products in which four cycled and interactive stages are included: (1) The superficial aesthetic stage, involving perceptions of physical characteristics, familiarity, typicality, aesthetic analyses of complexity, and the process of making comparisons between stimuli and the established framework. (2) the symbolic aesthetic stage, involving the aesthetic association of meanings and values, integration of subjective preference and normative values, and the integration of an intrinsic coding system and associative coded expression. (3) the conceptual aesthetic stage, concerning the conceptual evaluation of a product regarding its beauty and the emotion it inspires; four types of conceptual aesthetic outcomes may occur (beautiful, positive emotion; beautiful, negative emotion; ugly, positive emotion; ugly, negative emotion). (4) the functional aesthetic stage, involving the aesthetic judgment and aesthetic emotion occurring during or after the actual use of an everyday designed product. Notably, these implicit and explicit AE processes are influenced by subjective experiences; aesthetic life experience may enhance open-mindedness and facilitate the preference of designed products (Yeh & Peng, 2019). Because AE and creativity are closely related, interventions that contribute to facilitating these AE stages should help inspire creativity on designed products.

AE, in great part, involves the capacity to consciously perceive, respond to, evaluate, and be sensitive to both the natural environment and human creations (Leder, 2013; Nadal & Skov, 2013; Stojilović, 2017; Zeki et al., 2014). Chatterjee (2014) claimed that AE refers to particular attention given to reality, leading to special perceptions and experiences concerning an object, a situation, an event. Accordingly, the degree of attention or consciousness during the AE process is critical to AE, and it can vary greatly. Similarly, effective training of creativity emphasizes the importance of consciousness in the improvement of creativity. Sun et al. (2016) found that participants significantly improved their divergent thinking abilities after 20 training sessions; they concluded that improved creativity may result from top-down cognitive control. Along the same lines, Vartanian (2019) found that creativity was related to individual differences in executive functions, which involve conscious thinking. Other researchers (Ritter & Dijksterhuis, 2014; Smallwood & Schooler, 2015) also argued that creative discoveries require conscious thought. These findings suggest the importance of conscious

thinking during AE and creativity processes.

2.2. Integration of everyday AE and AE-based training

A growing body of research has found that personal traits involving artistic experience and openness to experience influence AE (Colver & El-Alayli, 2015; Krajewska & Waligórska, 2015; Myszkowski, Storme, Zenasni, & Lubart, 2014; Simpson & Thomas, 2018). Besides, the level of knowledge and personal experience created by the paintings predict an aesthetic appreciation, suggesting an interaction effect of personal traits and stimuli during an AE process (Jankowski, Francuz, Oleś, & Chmielnicka-Kuter, 2018). Similarly, it has been found that aesthetic life experience and expertise influence aesthetic preference and judgment (e.g., Nadal & Skov, 2013; Vessel, Starr, & Rubin, 2012). In this study, we included a personal trait concerning everyday AE in designed products.

The personality trait of everyday AE in designed products involves an open mind to aesthetic perceptions and analyses, aesthetic judgment and emotion, and everyday-experience association when viewing designed products in daily life (Yeh & Peng, 2019); such tendencies or abilities may moderate the learning of AE. Yeh, Hsu and Li (2018) analyzed the relationship between personal experiences concerning AE and various types of AE outcomes (aesthetic judgment and emotions) inspired by everyday products in the experiment; they found that people who had rich experience in product design were more able to bring about positive emotions when viewing beautifully designed products than those who had a poor experience. Similarly, it is reported that the personal trait of openness to experience, which is characterized by curiosity and receptivity to new experiences, was a predictor for AE (Colver & El-Alayli, 2015). Moreover, people with open attitudes toward AE were more prone to be inspired and, therefore, generated more creative solutions (An & Youn, 2018). fMRI study (Yeh, Lin, Hsu, Kuo, & Chan, 2015) also suggest that AE processes and outcomes are influenced by the mechanisms of memory retrieval, attentional control, emotional regulation, and adaptive response; notably, such mechanisms are formed through the interactions of personal experiences, expertise, social values, and neural substrates. In the same vein, it was found that rich everyday AE elicited more brain activations in aesthetic judgments; rich everyday AE modulates the integration of external sensation and internal states, top-down attention, reward processing, and emotion regulation when viewing beautiful stimuli (Yeh, Hsu, & Li, 2018). Supported by these empirical findings, we examined the moderation effect of an individual's everyday AE toward designed products in the AE-based interventions.

Creative thinking involves controlled memory retrieval, executive processes, idea evaluation, internally-directed attention, spontaneous cognition, idea generation, and emotion (Beatty et al., 2016; Di Domenico & Ryan, 2017). Although past literature has claimed that AE increases creativity (An & Youn, 2018; Yeh & Peng, 2019), few studies have focused on using different types of cognitive processes of product-based AE (i.e., superficial, symbolic, functional, and conceptual aesthetics) as interventions to enhance consciousness in creativity training. Based on the aforementioned literature, we identified four core strategies corresponding to the four AE processes, namely, perceptual analysis, life-experience association, functional analysis, and aesthetic-emotion evocation. These strategies may enhance focused attention and consciousness in AE processes, facilitate life experience association, activate working memory, prompt positive emotion, inspire creative ideas, and further improve personal product-based creativity. Meanwhile, the personal trait of everyday AE toward designed products may moderate the intervention effects on creativity improvement. The personality trait of everyday AE here refers to the tendencies or abilities in aesthetic perceptions and analyses, aesthetic judgment and emotion, and everyday-experience association when viewing designed products in daily life. The theoretical base of this study is depicted in Fig. 1.

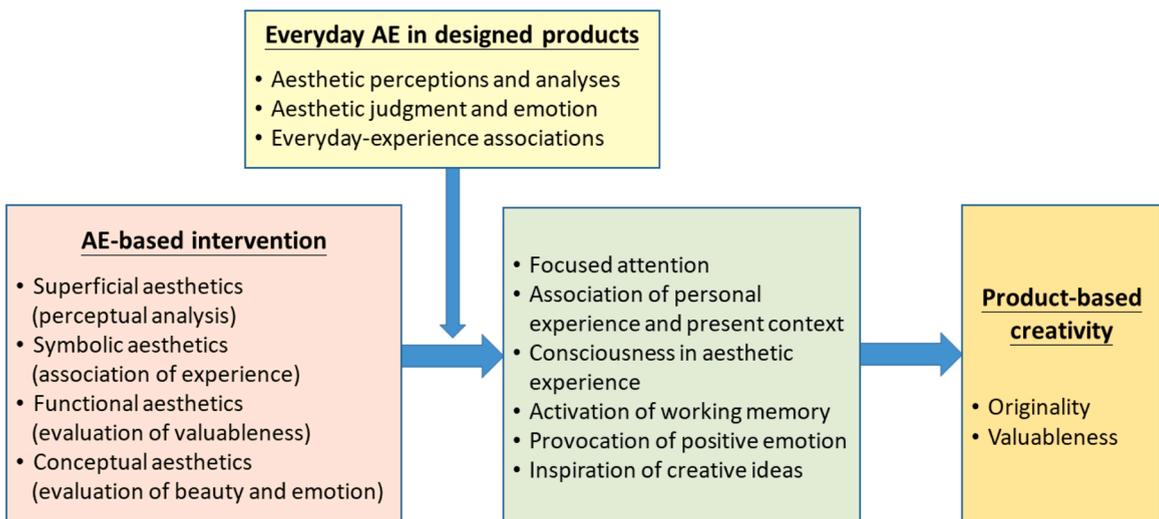


Fig. 1. The theoretical base of this study.

### 2.3. The present study

Aesthetics and creativity have become part of our lives. Interventions that enhance the connection between these two areas through the evaluation of mundane arts would have greater ecological validity and feasibility in learning and instruction. Based on the proposed theoretical base (Fig. 1), we included a control group and four AE strategy intervention groups (Perceptual analysis, Life-experience association, Functional analysis, and Aesthetic-emotion evocation) to examine their influences on creativity in this study. The rationale for separating the AE strategies was to identify the influence power of consciousness thinking on each of the important AE strategies, which help us understand what combinations of AE strategies may maximize the improvement of creativity and provide implications for the long-term instructional design. Specifically, we aimed to explore what types of AE-based interventions would lead to the best improvement of creativity and whether the trait of everyday AE would moderate the intervention effect and thus influence their creativity improvement. Notably, because aesthetic emotion and aesthetic judgment are two major outcomes of AE (Leder et al., 2004; Leder, 2013; Nadal & Skov, 2013; Zeki et al., 2014), we employed related evaluation questions for all interventions after participants observed a product photo. Also, it has been suggested that AE usually comes to full fruition by prompting an evaluative judgment and inducing personal emotion (Brattico & Pearce, 2013), we therefore added short descriptions in the intervention of functional analysis to facilitate evaluative judgment as well as in the intervention of aesthetic-emotion evocation to help induce personal emotion. The following hypotheses were proposed:

**Hypothesis 1.** When evaluating a designed product, enhancing college students' consciousness during the process of AE would improve their performance of creativity; however, this improvement would vary across interventions emphasizing different aesthetic strategies. Specifically, the intervention of functional analysis and that of aesthetic-emotion evocation would result in greater improvement than the other interventions.

**Hypothesis 2.** The trait of everyday AE would moderate the intervention effects and then carry effects on college students' improvement of creativity.

## 3. Method

### 3.1. Participants

Participants were 180 college students (74 males and 106 females) aged 18–35 ( $M = 21.3$  years;  $SD = 2.89$  years) recruited through online advertisements on campus. The participants were randomly assigned to a control group or to one of the four experimental groups under the consideration of gender equality. Each group consisted of 36 participants. The study was approved by the Research Ethics Committee of the university where the study was conducted. Written informed consent was obtained from all participants, and USD 10 was rewarded upon the completion of the experiment.

### 3.2. Instruments

#### 3.2.1. Stimuli of AE

Fifty photos of everyday designed products selected from Aesthetic Pictures of Everyday Designed Products were used as stimuli. Rated by 401 college students, these photos had mean scores of beautifulness above 4 points on a 6-point Likert-type scale (ranging from very ugly to very beautiful) (Yeh, Hsu, & Li, 2018). The reliability and validity of Aesthetic Pictures of Everyday Designed

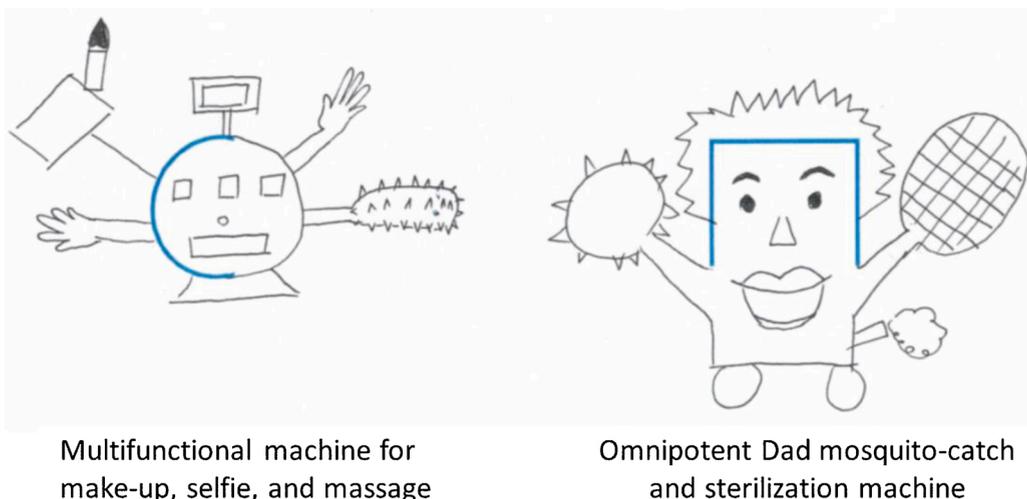


Fig. 2. Examples for PB-FCT.

	C	E1	E2	E3	E4
Intervention	<b>Free Observation</b> <i>Control group</i>	<b>Perceptual analysis</b> <i>Superficial aesthetics</i>	<b>Life-experience Association</b> <i>Symbolic aesthetics</i>	<b>Functional analysis</b> <i>Functional aesthetics</i>	<b>Aesthetic-emotion evocation</b> <i>Conceptual aesthetics</i>
Instructions	Appreciate the photo for 15 secs.	Appreciate the photo for 15 secs and pay attention to important characteristics, lines, shape, etc.	Appreciate the photo for 15 secs and make connections to your life experiences.	Appreciate the photo for 15 secs and think about its functions while reading the introduction.	Appreciate the photo for 15 secs and associate it with significant moments in your life while reading the introduction.
Stimuli					
				The champagne-cork-shaped USB 2.0 has a light weight of 30g and a great capacity of 8 GB. With SDA 3.0, it also has super-fast transmission.	Great wine, the catalyst of love and friendship, is a popular gift choice. The lovely champagne-cork-shaped USB will help you turn a moment of “drinking and singing” into a beautiful long-lasting memory.

Fig. 3. An example for instructions and stimuli.

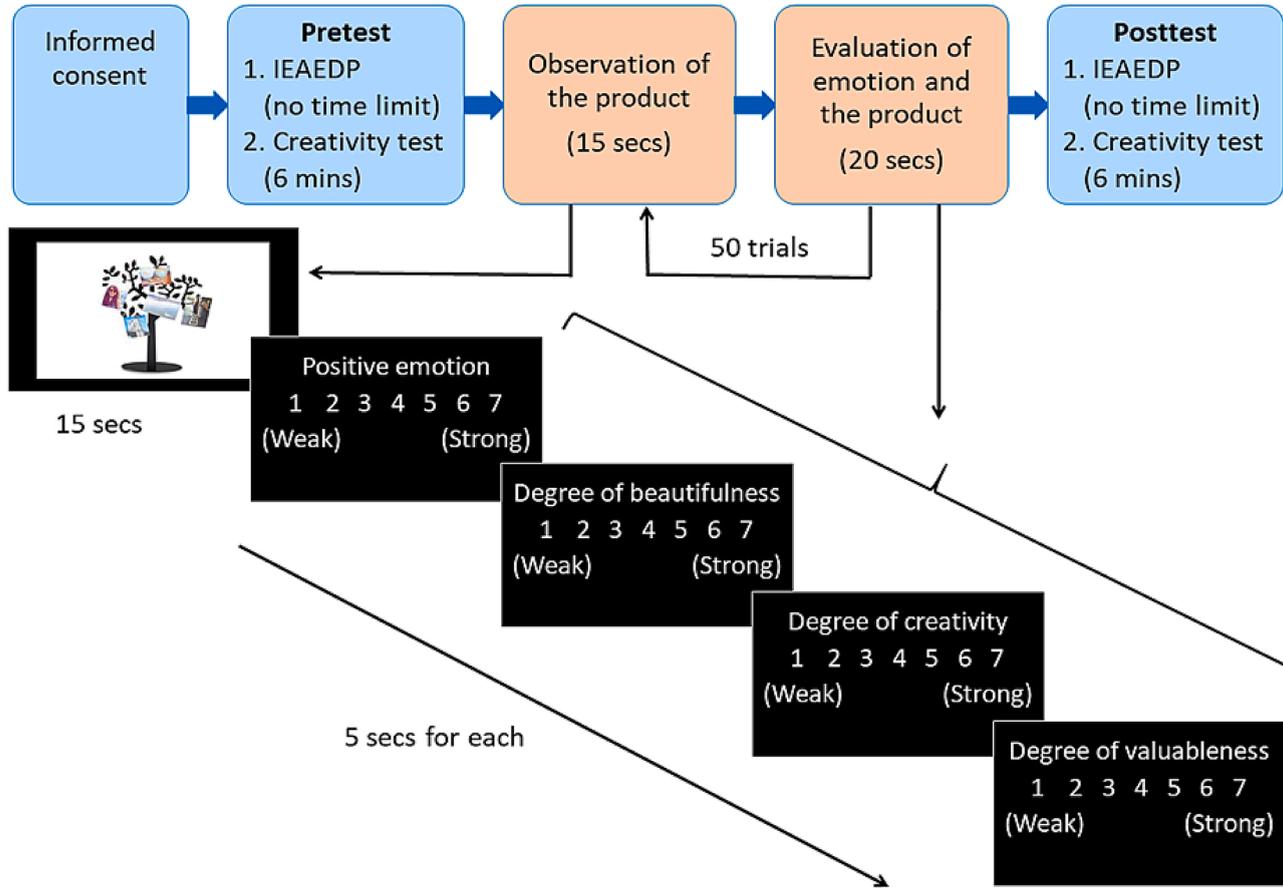


Fig. 4. Procedures of the experiment.

Products have been replicated by several studies (e.g., Yeh, Hsu, & Rega, 2019, Yeh, Hsu, & Li, 2018). Based on the sample of this study, the selected photos had a mean score of 4.912 (SD = .677) in beautifulness on a 7-point Likert-type scale (ranging from weak to strong).

### 3.2.2. Product-based figural creativity test

Because the stimuli of AE in this study were based on designed products, we used the "Product-based Figural Creativity Test" (PB-FCT) (Yeh, Hsu, & Rega, 2019) to measure the participants' creativity. The original PB-FCT included three subtests: □, C, and . □ is a Chinese phonetic symbol, C is an English letter, and . is a symbol commonly seen across cultures. The PB-FCT was designed to test whether the participants could escape from the restrictions of stereotypical thinking and to determine how many original and valuable products they could design. The scoring norm for the PB-FCT was established based on a sample of 407 college students, in which a total of 1,074 varied responses were obtained. The indices measured in the PB-FCT were "originality" and "valuableness" (Yeh, Hsu, & Rega, 2019). The correlations between originality and valuableness for C, □, and . were .755, .822, and .785,  $ps < .001$  (Yeh, Kao, & Peng, 2014). The scores of originality and the valuableness of the PB-FCT were also correlated with the originality score in the New Creative Thinking Test (Wu, 1998) ( $rs = .565$  and  $.711$ ,  $ps < .001$ ) which is a divergent thinking test.

Owing to limited time, we only employed two subtests (C and □) (see Fig. 2 for samples), with 3 min of response time for each one, to measure the participants' creativity in this study. During the experiment, the participants were requested to design original and functional products based on the figure of C and □. The score of each designed product was calculated by originality (0–4 points) × valuableness (0–3 points). Originality is the sum of "rareness" of a response (0 points:  $> = 5\%$ ; 1 point:  $> = 2\%$  and  $< 5\%$ ; 2 point:  $> = 1\%$  and  $< 2\%$ ; 3 points:  $< 1\%$ ) and the specialness of the designed product (0 or 1 points). "Valuableness" was scored by the number of different functions of a response when it was appropriate or useful. The scoring rules for validity were: 0 = not valid; 1 = has only one function; 2 = has two different functions; and 3 = has three or more different functions. The total score of creativity was the sum of scores of the designed products.

### 3.2.3. The inventory of everyday aesthetic experience in designed products

The "Inventory of Everyday Aesthetic Experience in Designed Products" (IEAEDP) (Yeh, Rega, & Chen, 2019) was employed to measure the participants' AE tendencies and abilities when viewing designed products in daily life. The inventory was a 4-point Likert-type scale with response options ranging from "never" to "always." The IEAEDP included 26 items with three factors: aesthetic perceptions and analyses (12 items), aesthetic judgment and emotion (11 items), and everyday-experience associations (3 items). Example test items include "I can analyze the design styles of a product," "Observing colorful products makes me happy," "I like to appreciate beautiful products," and "Familiar products can evoke my memories of happiness." The Cronbach's  $\alpha$  coefficients were .946, .917, .893, and .749 for the IEAEDP and the three factors, respectively. The correlation coefficients for the three factors were .436 to .558,  $ps < .001$ . Moreover, the confirmatory factor analysis indicated that the IEAEDP had a high level of construct validity (Yeh, Rega, & Chen, 2019).

## 3.3. Experimental design and procedures

To explore different types of AE-based intervention effects on the improvement of creativity, we designed one control group and four intervention groups corresponding to the four product-based AE processes (i.e., superficial, symbolic, functional, and conceptual strategies). The five groups were as follows: (1) the Control group with free product observation; (2) the Perceptual analysis group with focused attention on important characteristics, lines, shape, etc.; (3) the Life-experience association group with focused attention on making connections to personal life experiences; (4) the Functional analysis group with focused attention on thinking about product functions; and (5) the Aesthetic-emotion evocation group with focused attention on associating the product with significant moments in personal life. Each group was given an instruction before the stimuli were displayed and varied instructions were given to prompt different AE processes. The intervention strategies, instructions, and displayed stimuli for each group are shown in Fig. 3.

In this study, we requested the participants to observe a stimulus first. Then, they evaluated their aesthetic emotions and judgment toward the stimulus. We also measured their performance of creativity before and after the intervention. Specifically, all participants came to the computer laboratory to join the experiment. After signing the informed consent form, they proceeded to fill out the pretest questionnaires—the IEAEDP and the Product-based Figural Creativity Test (3 min for each subtest, 6 min. in total). Then, they completed 50 trials of the experiment. In each trial, a stimulus was presented for 15 s. Then, the participant was requested to answer the following questions (5 s for each) regarding her/his aesthetic emotion and judgment toward the stimulus: (1) Positive emotion; (2) Degree of beautifulness; (3) Degree of creativity; and (4) Degree of valuableness. All the questions were evaluated by a 7-point Likert-type scale from "1" point (weak) to "7" points (strong). These questions were employed to, first, enhance consciousness while observing the stimulus, and second, to understand the relationship of the aesthetic-related indices while viewing the stimulus. After completing the 50 trials, the participants completed the posttest, including the IEAEDP and the Product-based Figural Creativity Test (see Fig. 4).

## 4. Results

### 4.1. Intervention effects

Pearson correlation was employed to analyze the correlations among the evaluation indices concerning the aesthetic emotion and

judgment of the viewed product. The results revealed positive correlations among the indices of positive emotion, degree of beautyfulness, degree of creativity, and degree of valuableness,  $r_s = .614-.886$  ( $ps < .001$ ) (see Table 1).

To examine the effects of the five types of interventions on the improvement of the performance of creativity, we first used an Analysis of Variance (ANOVA) to examine the baseline creativity differences between the intervention groups. Then, we employed a repeated measure ANOVA with the five interventions as the between variable and with Test (pretest vs. posttest creativity score) as the within variable. The means of creativity scores for each group are displayed in Fig. 5. The results of ANOVA indicated that the five intervention groups did not differ in creativity performance before the interventions,  $F(4,175) = 1.476, p = .212, \eta^2_p = .033$ .

As for repeated measure ANOVA, the results showed no Intervention  $\times$  Test interaction effect,  $F(4,179) = .615, p = .653, \eta^2_p = .014$ . However, there were main effects of Intervention and Test,  $F(4, 179) = 2.536, p = .042, \eta^2_p = .055$ , and  $F(1, 179) = 21.34, p = .000, \eta^2_p = .109$ . With regard to Intervention effect on creativity improvement, comparisons of post hoc test revealed that the Aesthetic-emotion evocation group outperformed the Control group ( $p = .035$ ) and the Life-experience association group ( $p < .014$ ), the Perceptual analysis group outperformed the Life-experience association group ( $p = .034$ ), and the Functional analysis group outperformed the Life-experience association group at a marginal significant level ( $p = .053$ ). Overall, the participants across groups improved their creativity after the intervention (see Table 2).

4.2. The moderation effect of everyday AE on interventions and the performance of creativity

The IEAEDP was employed to measure the participants' everyday AE regarding their aesthetic perceptions and analyses, aesthetic judgment and emotion, and everyday-experience association. The participants were divided into the High and the Low groups by the median. To examine whether the personal trait of everyday AE would moderate the effects of interventions on creativity improvement, we conducted a Group (Low vs. High group)  $\times$  Intervention (the five intervention groups) ANCOVA analysis by using the pretest score of creativity as the covariance and the posttest score of creativity as the dependent variable. Notably, we used repeated measure ANOVA to examine intervention effects (Hypothesis 1) because we were more concerned about the differences in growth between interventions. Here we employed ANCOVA to test Hypothesis 2 because we were more concerned about estimating differences between intervention groups on the posttest of creativity after adjusting for differences in the pretest. These two types of analyses give us different angles on examining the results.

The results showed a Group  $\times$  Intervention effect,  $F(4, 167) = 2.602, p = .038, \eta^2_p = .059$ . The main effect of Intervention was not significant,  $F(4, 167) = 1.858, p = .120, \eta^2_p = .43$ , and neither was the main effect of Group,  $F(1, 167) = 3.551, p = .061, \eta^2_p = .021$ . The followed analysis of simple main effects revealed that the participants in the Low-AE group made more improvements in creativity in the Perceptual analysis group than in the Life-experience association group ( $p = .025$ ) as well as made more improvements in creativity in the Aesthetic-emotion evocation group than in the Life-experience association group or the Functional analysis group ( $ps < .05$ ). For the High-AE group, those in the Functional analysis group made more improvements in creativity than those in the Control group or the Life-experience association group ( $ps < .005$ ). When examining the difference of the Low-AE vs. the High-AE group within each of the interventions, only a significant difference was found in the Functional analysis group; the High-AE group outperformed the Low-AE group ( $p = .006$ ) (see Table 3 and Fig. 6).

5. Discussion

5.1. Intervention effects

Most studies of AE have focused on abstract art; only a few studies (e.g. Yeh, Hsu, & Li, 2018, Yeh, Hsu, & Rega, 2019) have used mundane art (e.g. creative design of a lamp or a USB) as stimuli to assess AE processes or learning effects. AE about creative design has become an important part of human life in modern society; it involves the aesthetics of superficial characteristics, the symbolic association of meanings and values, the conceptual evaluation of beauty and emotion, and the functional evaluation of product valuableness (Yeh, Rega, & Chen, 2019). Because AE and creativity share a lot of complex cognitive processes during the process of AE and creative thinking, this study integrated the key concepts of AE regarding designed products to design five interventions. Through these interventions, we explored what types of AE-based interventions would best facilitate college students' performance of creativity. The five intervention groups were: Control, Analysis of aesthetic perceptions, Association of life experience, Evaluation of product valuableness, and Evocation of aesthetic emotion. Regardless of the varied instructions and stimulus formats for each of the interventions, all groups completed questions regarding product evaluation for each stimulus.

We postulated that when observing a designed product, enhancing college students' consciousness during the process of AE would

Table 1  
Correlations among indices of assessing stimuli.

	Emotion	Beautyfulness	Creativity	Valuableness
1. Emotion	1			
2. Beautyfulness	.886***	1		
3. Creativity	.789***	.875***	1	
4. Valuableness	.614***	.718***	.761***	1

\*\*\*  $p < .001$ .

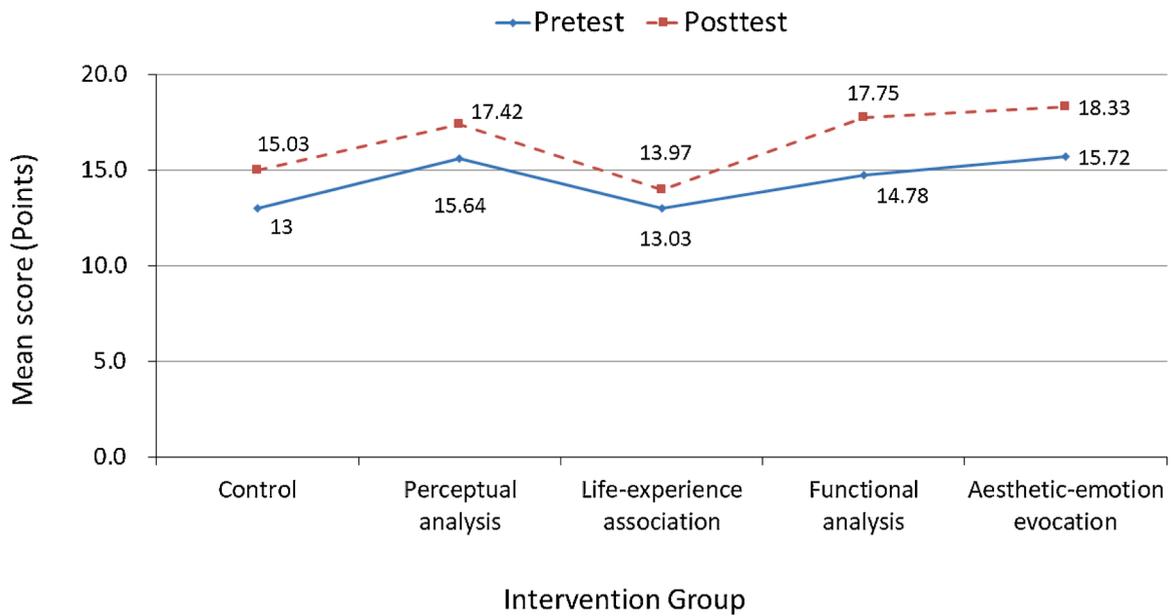


Fig. 5. Means of different intervention groups in the pretest and the posttest of creativity.

Table 2  
Results of Intervention × Test repeated measure ANOVA.

Source	ANOVA					Post hoc test (LSD)
	MS	df	F	p	$\eta^2_p$	
Intervention	183.185	4	2.536*	.042	.055	E4 > C, E2 (ps < .05) E1 > E2 (p = .034) E3 > E2 (p = .053)
Test	384.400	1	21.340***	.000	.109	Posttest > pretest
Intervention × Test	11.074	4	.615	.653	.014	

Note. Intervention: C = Control group; E1 = Perceptual analysis group; E2 = Life-experience association group; E3 = Functional analysis group; E4 = Aesthetic-emotion evocation group.

\* p < .05.

\*\*\* p < .001.

Table 3  
ANCOVA results of everyday AE × Intervention on the performance of creativity.

Source	ANOVA				Simple main effect
	MS	F	p	$\eta^2_p$	
Pretest	2581.457	91.518***	.000	.354	
Intervention	52.422	1.858	.120	.043	
Group	100.160	3.551	.061	.021	
Group × Intervention	73.387	2.602*	.038	.059	Group <sub>L</sub> : E1 > E2 (p = .025) E4 > E2, E3 (ps < .05) Group <sub>H</sub> : E3 > C, E2 (ps < .05) E3: Group <sub>H</sub> > Group <sub>L</sub> (p = .006)

Note. Intervention: C = Control group; E1 = Perceptual analysis group; E2 = Life-experience association group; E3 = Functional analysis group; E4 = Aesthetic-emotion evocation group. Group: Group<sub>L</sub> = Low-score group of everyday AE; Group<sub>H</sub> = High-score group of everyday AE.

\* p < .05.

\*\*\* p < .001.

improve their performance of creativity; however, this improvement would vary across interventions. Overall, this hypothesis was supported. We found that all groups improved their creativity after the intervention. This finding suggests that even when only questions regarding product evaluation were employed, consciousness in AE can be enhanced, although the effect was limited. Such a finding demonstrates that rating artwork is related to performing a creative activity (Stojilović, 2017). Moreover, we found highly positive correlations among the four evaluation questions (i.e., positive emotion, beautifulness, creativity, and valuableness), which

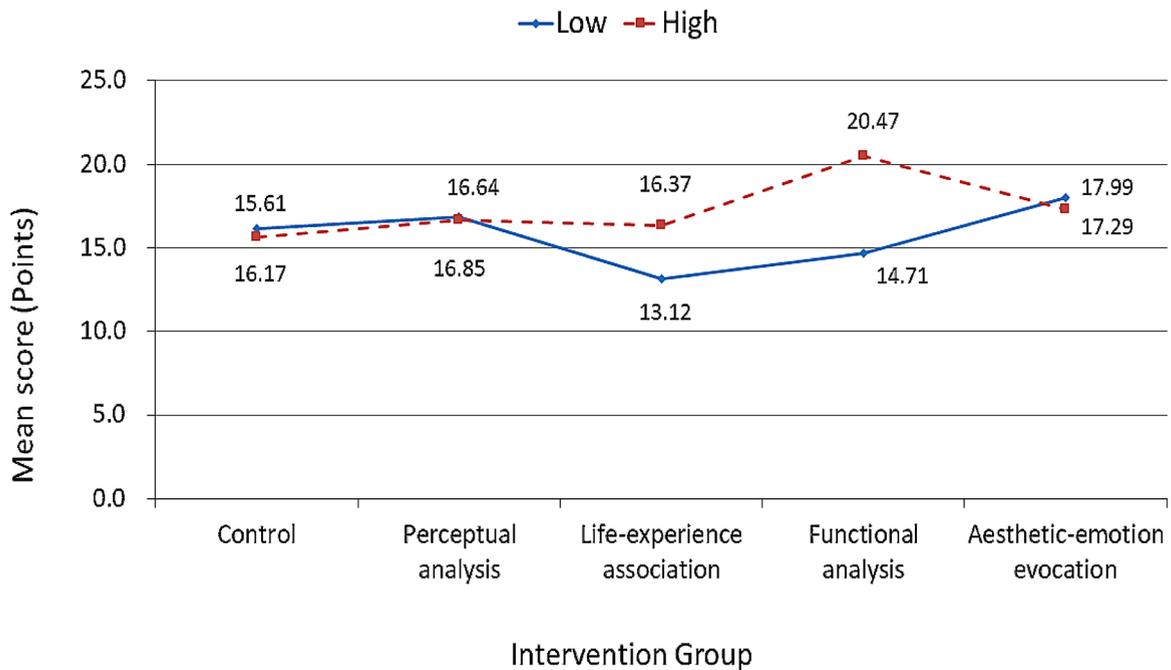


Fig. 6. Creativity scores of the Low- vs. the High-score group of everyday AE in the intervention groups.

lends support to the argument that aesthetics, design, art disciplines, and creativity are closely related (Clinton & Hokanson, 2012; Saorín et al., 2017). In other words, the findings here support our rationale for enhancing creativity through AE-based interventions.

Notably, the findings of this study support our hypothesis that emphasizing consciousness for certain aspects of AE, especially those focused on functional analysis and aesthetic-emotion evocation, would bring about greater improvement than the other interventions. The results support that enhancing consciousness in AE through specific instruction for focused attention contributes to inspiration for original and valuable product design. People are often inspired not by random things but by things that resonate with their deeply held values and meaning structures, which creates an opening for inspirational transcendence and shift in consciousness (Azarova, 2020). The positive intervention effect found in this study supports that that creativity is associated with consciousness, experience, and practice (Sawyer, 2011). The findings here also suggest that AE is part of our everyday lives and that aesthetic abilities can be cultivated by enhancing awareness in aesthetic judgment (Yeh, Rega, & Chen, 2019). Accordingly, engaging college students in conscious practices of AE inspires their creativity.

In this study, we assumed that receiving interventions with short descriptions regarding product functions and the touching moment would lead to greater improvement in creativity than receiving the other interventions. The results revealed that the Aesthetic-emotion evocation group outperformed the control group and the Life-experience association group; moreover, the Functional analysis group outperformed the Life-experience association group at a marginal level. These findings suggest that incorporating narratives that prompt consciousness and recollection of emotional memories in one’s life leads to the best intervention effect. Moreover, the outstanding performance of the Aesthetic-emotion evocation group also suggests that the descriptions for evoking aesthetic emotions help bring about strong connections between the participants, their life experiences, their true selves, and the present context. Aesthetic judgment and aesthetic emotion are greatly influenced by working memory and emotion (Bertamini, Makin, & Rampone, 2013; Leder, 2013; Nadal & Skov, 2013; Okanoya, 2014). The findings here are in line with the claim that positive mood states stimulate creativity by increasing working memory capacity (De Dreu, Baas, & Nijstad, 2008), as well as that aesthetic abilities can be enhanced by evoking positive emotional associations toward designed commodities (Yeh, Rega, & Chen, 2019). In other words, adding narratives about the product contributes to associations and activation of working memory and emotions, which helps in generating creative ideas.

Interestingly, we found that consciousness on perceptual analysis of product also has a decent effect on creativity improvement, which lends supports to the finding that visual aesthetic sensitivity (which is the perceptual ability to identify differences in terms of harmony or symmetry) is positively correlated with creative potential, measured by a figural divergent thinking task (Myszkowski et al., 2014). However, this study found that, when the life-experience association was encouraged without the scaffolding of narratives (the Life-experience association group), or when the product photos were presented without the scaffolding of AE attention (the Control group), the effects on the following creativity test concerning product design were minimum. These findings suggest the importance of scaffolding during AE interventions as well as the argument that creative discoveries involve conscious thought (Ritter & Dijksterhuis, 2014; Smallwood & Schooler, 2015). Accordingly, the findings of this study suggest that provoking consciousness during the AE process enhances creative performance.

## 5.2. Influence of everyday AE on creativity

In this study, everyday life AE refers to the experience involving aesthetic perceptions and analyses, aesthetic judgments and emotions, and association with everyday experience about everyday designed products. We postulated that college students' personality trait of everyday life AE would moderate AE-based learning. The hypothesis was supported. The result revealed that participants who had a lower level of everyday AE benefitted more in the Perceptual analysis group and the Aesthetic-emotion evocation group (especially in the Aesthetic-emotion evocation group) than in the other intervention groups. However, participants who had a higher level of everyday AE benefitted more in the Functional analysis group than in the Control group or the Life-experience association group; they also outperformed those with a lower level of everyday AE in the Functional analysis group. Again, the findings revealed that, regardless of everyday AE, participants benefitted less when the scaffolding of focused attention was not provided at the initial stage. Notably, encouraging functional analysis seems to provide the best support for those with a higher level of everyday AE. The creativity test employed in this study emphasizes both originality and valuableness. The results here reflect that, for people who have weak aesthetic sensitivity toward beautiful and creative products in their surroundings, their creativity increases more when they are encouraged to mindfully read narratives that induce aesthetic emotion and original ideas. In contrast, for people who already have strong aesthetic sensitivity, more practice in functional analysis is required to enhance their inspiration for Coming up with valuable products.

Related findings (Yeh, Rega, & Chen, 2019) have suggested that rich everyday AE contributes to the association of beautifully designed products with positive emotion, which may result in a high level of appreciation for the products. When people have rich everyday AE, they may be more open and sensitive to beautiful things or products in their surroundings. Open-mindedness is an essential component for AE and creativity in the visual art domain; it involves active imagination, aesthetic sensitivity, preference for diversity, intellectual curiosity, and independent thinking. Moreover, when people are open to new and unusual experiences, it enhances positive mood and leads to greater flexibility and freedom of ideation (Stojilović, 2017). This may be the reason that people who had rich aesthetic experience did not significantly improve their creativity in the aesthetic-emotion evocation intervention group. However, people who have poor everyday life aesthetic experience may be unable to effectively make associations between their life experience and positive emotion. As a result, under the scaffolding of emotion association, they significantly improved their creativity. These results lend support to the argument that aesthetics comprise various sources of individual differences, including openness, sensitivity to complexity, art knowledge, aesthetic empathy, attention, and exploratory perception tendencies, which are important both for aesthetic evaluation and creative production (Myszkowski & Zenasni, 2016).

## 6. Conclusions

To date, little is known about how varied intervention of AE strategies is associated with individual creativity. This study integrated the cognitive process of AE in everyday designed products, by which we proposed a framework for AE-based interventions and constructed five interventions for enhancing creativity. We further explored what types of AE interventions would enhance college students' consciousness of AE and, then, lead to the improvement of creativity learning. Moreover, we examined whether college students' personality trait of everyday AE would interact with the interventions and, then, influence their creativity improvement. The results showed that engaging the participants in conscious practices of AE, especially those that contribute to the association between imaginary narratives and the participants' life experiences or that enhance analytical thinking on valuableness of the product, can best improve college students' creativity. In contrast, a free association of life experiences or the absence of reminders to engage in AE leads to less improvement in creativity. Moreover, the interactions between varied interventions and everyday AE suggest that providing scaffolding in accordance with an individual's trait of everyday AE is required, which can magnify the effects of learning creativity during AE-based training. To conclude, this study theorizes and examines the link between varied AE-based practices and the performance of creativity as well as the moderation role of everyday life AE in such learning. The findings provide a new approach for enhancing creativity as well as valuable insight for instruction and research design in related areas.

## 7. Limitations and implications

This study requested the participants to rate the aesthetic emotion and judgment of photos of everyday designed products. The results suggest that, even when only observing photos and then evaluating them without any direct AE strategy instructions, people can significantly improve their creativity. This reflects the importance of rating or aesthetic judgment on enhancing consciousness during the process of AE or the learning of creativity. Accordingly, in design-related creativity training, self-evaluation or peer evaluation can be employed to enhance the consciousness of AE and creativity processes. Moreover, this study did not employ a group that only observed product photos without further assessing the products. Further studies can add such a group to examine whether there are differences between such an intervention and the interventions employed in this study, which will help further verify the effects of evaluating products on creativity facilitation.

Furthermore, the findings of this study suggest that guiding people who lack everyday AE to an imagery situation may evoke memories of emotional moments in their lives, which further increases their originality in product design. However, leading people who are open to everyday AE to a functional analysis situation may enhance their analytical thinking on the valuableness of product design. Accordingly, instructional design to enhance college students' creativity should provide appropriate scaffolding in accordance with their personal experiences. Notably, because originality and valuableness are two essential components of product creativity, enhancing both creative abilities may result in the best learning effect. This study clarifies the effects of these two types of interventions

separately. Further studies can design a compound intervention including both types of interventions to examine its effects on AE or creativity. Moreover, the narratives provided in the Functional analysis group and the Aesthetic-emotion evocation group are provided by the researcher. Future studies can request the participants to generate their own narratives if time allows; this could prompt more in-depth and stronger emotions or associations. Along the same line, the findings revealed that the Aesthetic-emotion evocation group, the functional analysis group, and the perceptual analysis group had a better learning effect. Future studies can combine these AE strategies to design a long-term course to maximize learners' improvement in creativity.

Finally, in this study, the AE intervention was employed through computers, and creativity was assessed by a paper-and-pencil creativity test emphasizing both originality and valuableness. In classroom teaching, a longer period of AE-based intervention with real photos taking by learners themselves could amplify the learning effects. Moreover, the performance assessment that requests participants to design their own products can be added to allow the full fermentation of creative ideas and to optimize creative performance.

### CRedit authorship contribution statement

**Yu-chu Yeh:** Conceptualization, Supervision, Methodology, Formal analysis, Visualization, Writing - original draft, Writing - review & editing, Funding acquisition. **Wei-Chin Hsu:** Software, Investigation, Data curation. **Evgeniy Yastrubinskiy:** Writing - original draft.

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