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# THE POWER OF BEAUTY: LEVERAGING ON DEEP LEARNING TO DISENTANGLE THE EFFECT OF IMAGE AESTHETICS ON ONLINE PURCHASE

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# THE POWER OF BEAUTY: LEVERAGING ON DEEP LEARNING TO DISENTANGLE THE EFFECT OF IMAGE AESTHETICS ON ONLINE PURCHASE

*Research in Progress*

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## **Abstract**

*Visuals have been deemed as one of the primary marketing formats in service e-tailing environments to compensate for the abstract and intangible nature of services. Yet, despite the overwhelming empirical evidence attesting to the importance of aesthetics in product and website designs, there is a dearth of research on how the beauty of images depicting service offerings could affect consumers' behaviour. Subscribing to Stimuli-Organism-Response (S-O-R) framework, we attempt to elucidate the power of aesthetics in shaping consumers' cognitive and emotional responses when they are exposed to the portal image of a service offering. Additionally, we endeavour to explore the heterogeneity of consumers' responses or their centrality of visual aesthetics, to such images. Blending computer vision and deep learning techniques, we advance a computable and decomposable aesthetic assessment method for scoring the aesthetics of portal images belonging to more than 299,000 local service offerings on a leading Chinese group buying site. We then employ Propensity Score Matching (PSM) to yield initial evidence demonstrating that aesthetics exerts significant effects on the online sales of services.*

*Keywords: Image aesthetics, Service e-tailing, S-O-R framework, Deep learning.*

## 1 Introduction

The digitalization of commerce has radically altered consumers' evaluation yardsticks and vendors' marketing strategies (Zhang et al., 2014). Although online environments have greatly expanded the avenues through which vendors can broadcast their services, the portrayal of services within such environments remains challenging due to the latter's intangible nature (Grove et al., 2002). The inability to physically examine a service has been hailed as the main impediment behind consumers' reluctance to purchase services online as the evaluation of most services would require some form of sensory interactions (Kim and Lennon, 2008). Consequently, visual representation, as the primary differentiable sensory cue in the digital world, constitutes the dominant communication tactic employed by vendors to accentuate the merits of their service offerings in hope of reducing consumers' perceptions of risk and uncertainty (An, 2014, Lupyán and Spivey, 2010).

Unlike verbal descriptions, visual cues in the likes of images has been acknowledged as having the capability to grab consumers' attention (Moriya, 2018), thereby playing an instrumental role in driving the latter's purchase intention, satisfaction, and willingness to pay for the portrayed service online (Azimi et al., 2012, Hill et al., 2004, van Enschoot and Hoeken, 2015). Particularly, past studies on service marketing has revealed that the aesthetic value of physical servicescapes not only affects consumers' psychological appraisal of offline service environments (Wang et al., 2010), but it also dictates their cognitive evaluations of service quality (Hooper et al., 2013). Likewise, extant literature on e-commerce has attested to the decisive role of aesthetics on website designs (Wang et al., 2010, Lavie and Tractinsky, 2004, Jiang et al., 2016, Cyr et al., 2009). Whilst prior research has established a solid foundation for exploring visual aesthetics of website designs (Porat and Tractinsky, 2012), few have delved into the impact of image aesthetics in fostering consumers' online purchase behavior. Subscribing to the Stimuli-Organism-Response (S-O-R) framework, this study attempts to unravel the power of aesthetics in service e-tailing by investigating how consumers react to the beauty artifacts of portal images depicting service offerings online.

Even though image aesthetics can be conceived as the artistic impression of beauty (Wang et al., 2011), its effect varies according to viewers' centrality of visual aesthetics (Vieira, 2010). Viewers' centrality of visual aesthetics, which comprise their acumen and valuation of visual aesthetics as well as their reaction to aesthetic designs, has been demonstrated to be deterministic of the extent to which visual aesthetics factor into purchase decisions (Bloch et al., 2003, Yoo and Kim, 2014, Mowen et al., 2010). We hence cater for heterogeneity in consumers' preference for image aesthetics by taking into account how variations in viewers' centrality of visual aesthetics would dictate the persuasiveness of portal images.

Past studies on the impact of visual elements on service sales were constrained to objective image attributes (e.g., colors, brightness, and image segmentations) that are derivable from conventional computer vision techniques (Zhang et al., 2017). Yet, there is growing recognition that individuals' perceptions of aesthetics are formulated according to their subjective impression of the beauty artifacts for the focal object, which include the formality of the layout (Sheng and Teo, 2012), the harmony of color combination (Lorenzo-Romero et al., 2013), and the novelty of the visual content (Crilly et al., 2004). Espousing a state-of-the-art deep learning algorithm trained on a large-scale human annotated dataset consisting of individual's subjective evaluation of 11 photographic attributes associated with aesthetics (Kong et al., 2016), we advance one of the first image aesthetic assessment methods in the service e-tailing domain to automatically rank aesthetics of portal images depicting service offerings.

To this end, this study synthesizes the S-O-R framework, centrality of visual aesthetics, and deep learning techniques to disentangle the effect of image aesthetics on consumers' online purchase intentions. Specifically, we strive to: (1) articulate how image aesthetics may influence service e-tailing in online environments by stimulating consumers' cognitive responses and emotional states; (2) explicate how consumers' reaction to beauty could be moderated by their centrality of visual aesthetics; as well as (3) take the first step toward comprehending image aesthetics by scrutinizing the

power of beauty at a collective level via deep learning to uncover its role in promoting online sales of services.

## **2 Theoretical Foundation**

### **2.1 Service E-Tailing and Visual Aesthetics**

Unlike physical products, evaluating service offerings in the likes of holiday packages, hotel accommodations, and restaurants is much more challenging due to the heterogeneous, inseparable, intangible, and perishable nature of services (Parasuraman et al., 1985, Miller and Foust, 2003). This is made worse in service e-tailing environments in that vendors struggle to convey the core benefits of their offerings over a lean medium (Ding and Keh, 2017, Wang et al., 2010). For this reason, it is unsurprising that prior research on service e-tailing has advocated visually-oriented communication tactics that rely primarily on pictorial elements to build association, physical representation, and visualization (Stafford, 1996, An, 2014). Indeed, there is an abundance of evidence that has affirmed the effectiveness of visual aesthetics (Lin, 2016) in driving consumers' evaluation of services (Vieira, 2010, Fiore et al., 2000). For example, Hill et al. (2004) discovered that the persuasiveness of image outperforms those of text because the vividness of visual elements could circumvent the hurdle of intangibility and contribute to a more concrete evaluation of service quality. In the same vein, An (2014) documented that the emotional appeal of visual cues not only enable consumers to mentally experience the service, but it also galvanize their imaginations on the physical representation of the service scape. Apart from influencing individuals' perceptions, past studies have also testified to the saliency of visual aesthetics in decision making. According to Wang et al. (2011), aesthetics represent "how different elements and attributes are combined to yield an impression of beauty". Visual aesthetics can elicit consumers' psychological appraisal of the service environment by inducing emotional echoes of arousal, pleasure (Lavie and Tractinsky, 2004, Vilnai-Yavetz and Tifferet, 2009), and desirability (Vilnai-Yavetz and Rafaeli, 2006).

Yet, despite the general consensus on the importance of visual aesthetics in shaping consumers' psychological appraisal of offline service environments, past studies on visual aesthetics within the information systems discipline have largely centered on the design of web artifacts (Jiang et al., 2016, Cyr et al., 2009, Deng and Poole, 2010). For example, Cyr et al. (2009) discerned website aesthetics as a salient driver of website appeal. In the same vein, Jiang et al. (2016) advanced the concepts of complexity, intensity, interactivity, novelty, and unity as constituent dimensions of website aesthetics that influence consumers' attitudes and perceived utility. Subscribing to the S-O-R framework, Porat and Tractinsky (2012) delineated between classical and expressive aesthetics of online store design as determinants of individuals' emotional responses to the perceptual aesthetics of web artifacts. Nevertheless, Porat and Tractinsky's (2012) conception of aesthetics may not be applicable to the presentation of a single image due to its emphasis on the holistic design of advertisement, servicescape, and website (Lin, 2016). Conversely, Zhang et al. (2017) are among the first researchers who have considered the impact of image attributes on consumer demands in shared housing by employing conventional computer vision techniques to extract basic and objective features pertaining to color, composition, and figure-ground relationship. Though Zhang et al.'s (2017) work has testified to the relevance of elementary photographic features of images in driving consumer demands, the lack of sophistication and subjectivity for the derived image attributes may somehow limit our comprehension on the power of image aesthetics. Departing from Porat and Tractinsky (2012) and Zhang et al. (2017), we embrace a subjective view of image aesthetics that takes into account individuals' subjectivity in perceiving beauty and draw on the S-O-R framework to offer an in-depth appreciation of the role of image aesthetics in promoting online sales of services.

## **2.2 The Stimuli-Organism-Response (S-O-R) Framework: An Overview**

The S-O-R framework elucidates the mechanism through which physical and social environments may influence individuals' decisions (Mehrabian and Russell, 1974). The S-O-R framework holds that environmental stimuli (S) may elicit emotional reaction (O) and in turn, alter individuals' behavioral responses (R) (Wang et al., 2010). Mehrabian and Russell (1974) have alluded to three emotional states (i.e., arousal, dominance, and pleasure) that mediate the effect of environmental stimuli on behavioral outcomes. Even though Mehrabian and Russell (1974)'s S-O-R framework has mainly accentuated individuals' affective responses to the environment, they conceded that emotional reactions would necessitate a cognitive interpretation of the cues from which affective impressions are formulated. Eroglu et al. (2001) thus extended the original S-O-R framework by incorporating cognitive response as another internal state that can jointly determine individuals' behavioral outcomes. Whereas cognitive responses are indicative of consumers' rational assessment of the focal object (e.g., perceived quality) based on their interpretation of the stimuli (Crilly et al., 2004), affective responses are aligned with Mehrabian and Russell (1974)'s conception of emotional reactions (Wang et al., 2013).

Since its inception, the S-O-R framework has been applied extensively to investigate how the design of digital artifacts may elicit affective and cognitive responses that govern consumers' purchase behavior (Wang et al., 2010, Lin, 2016, Animesh et al., 2011, Xu et al., 2014). From these studies, visual aesthetics has emerged as the predominant impetus that underlies the S-O-R process (Eroglu et al., 2001, Kim and Lennon, 2013, Bell, 1999). Bell (1999) observed that the fashionableness and visual amenity of the service scape could induce consumer's favorable perception towards the retail environment, culminating in an increased willingness to purchase. In the same vein, website aesthetics has been found to invoke consumers' feelings of arousal and pleasure (Lin, 2016), as well as their perception of service quality (Wang et al., 2011), which in turn translate into brand loyalty (Wang et al., 2010), purchase intention (Lin, 2016), and satisfaction (Vilnai-Yavetz and Rafaeli, 2006).

## **2.3 Centrality of Visual Aesthetics**

Aesthetic centrality captures individual discrepancies in response to visual aesthetics (Bloch et al., 2003). Bloch et al. (2003) put forth one of the first measures of consumers' Centrality of Visual Product Aesthetics (CVPA) that reflects the degree to which a consumer relies on the visual aesthetics of a product for decision making. Bloch et al. (2003) highlighted the criticality of comprehending CVPA by demonstrating that the level of CVPA tends to shape how consumers processes product aesthetics (e.g., peripherally or systematically). Extending CVPA to physical store designs, Vieira (2010) uncovered that centrality of visual aesthetics can be construed as a multidimensional concept that embodies an individual's: (1) perceived value of aesthetics (value); (2) acumen in recognizing and evaluating aesthetic artifacts (acumen), as well as; (3) reaction to aesthetics (response).

Consistent with the work of Bloch et al. (2003), prior research has bear witness to aesthetic centrality in mitigating the persuasiveness of visually-oriented information (Bloch and Kamran-Disfani, 2018, Vieira, 2010). Through the identification of antecedents and consequences of aesthetics centrality, Mowen et al. (2010) concluded that the power of beauty works in conjunction with personal traits that encapsulate aesthetics centrality. Likewise, scholars have pointed to the moderating influence of consumers' acumen and reaction towards visual aesthetics in determining their reaction to the retail environment (Bloch and Kamran-Disfani (2018), which in turn affect their loyalty, satisfaction, shopping duration, and willingness to pay (Vieira, 2010).

## **3 Research Model and Hypotheses Formulation**

Drawing on the S-O-R framework and extant literature on aesthetic centrality, we construct a research model (see Figure 1) that not only expounds the mechanisms underpinning how the aesthetics of the portal image for a service offering would drive consumers' online purchase decisions, but also

illuminates the moderating influence of consumers' centrality of visual aesthetic in mitigating the impact of aesthetic stimuli in shaping individual's cognitive responses and emotional states.

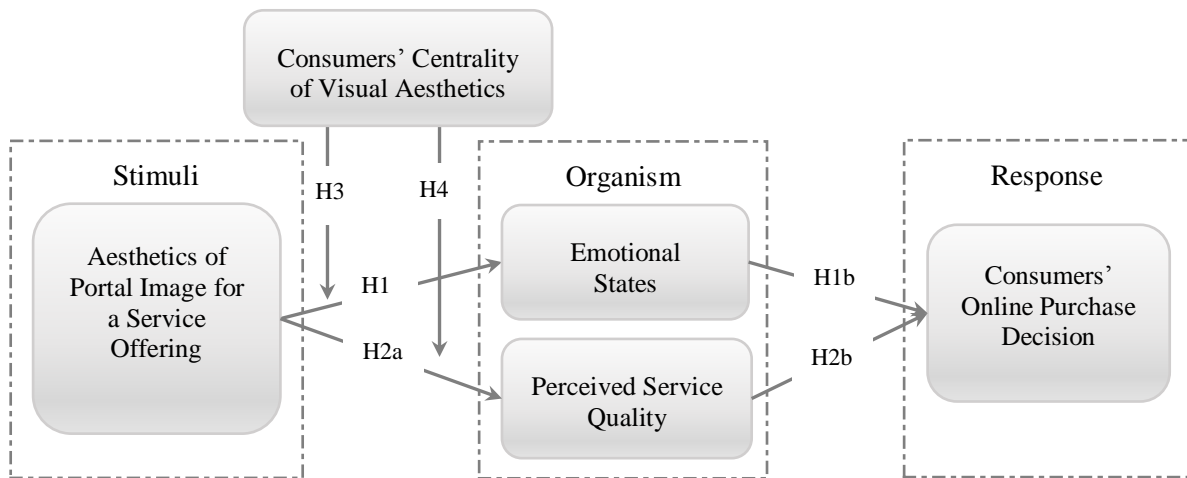


Figure 1. Research Model

The aesthetics of the portal image of a service can affect consumers' buying decisions by eliciting their emotional states, activating one's sense of arousal, dominance, and pleasure (Mehrabian and Russell, 1974). First, image aesthetics can induce hedonic benefits not only because viewing appealing pictures could stimulate feelings of pleasure (Vilnai-Yavetz and Rafaeli, 2006, Lin, 2016), but also because the aesthetically pleasing elements of a service image could align consumers' mental imagery with the emotional value they could extract from the consumption experience (Cyr et al., 2009). For example, viewing a restaurant image, which depicts a conducive dining environment, may evoke viewers' association with the potential enjoyment they could gain from dining in the restaurant. Second, the beautiful visualization of a service tends to attract more attention, serving as a stronger stimulus of emotional arousal (Hill et al., 2004, Jiang et al., 2016). Third, to structure an aesthetically appealing portal image would usually require the vendor to present the distinct features of the service in a formal manner (Wang et al., 2011). Such aesthetic formality is helpful for consumers to navigate their comprehension of the service content which in turn culminates in a sense of dominance (Chang et al., 2014, Wang et al., 2013, Porat and Tractinsky, 2012). While past studies tend to exclude the level of perceived dominance as a dimension of emotional states (Zhang, 2013), the environmental stimuli can still entice a higher level of emotional states among consumers by creating a greater sense of arousal and pleasure (Mehrabian and Russell, 1974), which would ultimately influence service purchase (Zhang et al., 2014, Wang et al., 2010). We therefore hypothesize that:

**H1a: The aesthetics of the portal image for a service offering is positively associated consumers' level of emotional states.**

**H1b: Consumers' level of emotional states is positively associated with their purchase decisions.**

Apart from affective response, extant literature also highlighted cognitive response as another dimension of individuals' internal states that is induced by environmental stimuli (Eroglu et al., 2001, Crilly et al., 2004, Mosteller et al., 2014, Van der Heijden, 2004). Though past studies have assessed various aspects of cognitive response such as perceived utility (Creusen et al., 2010, Jiang et al., 2016) and perceptual fluency (Mosteller et al., 2014), perceived service/product quality tends to be the predominant representation of cognitive response that drives consumers' attitudes and decisions (Wang et al., 2011, Lin, 2016). A well-structured portal image not only assists consumer's comprehension in the value of the focal service, but also signals the vendor's competence and sincerity in delivering the service. Extant literature builds clear linkage between aesthetics and perceived quality because: (1) the beauty elements of a service offering directly bolsters viewers perception of

service quality (An, 2014, Jiang et al., 2016), and (2) the aesthetic formality of an image also facilitates viewer's valuation of the tangible cues revealed in the image (Jiang et al., 2016). The intention to display a sophisticated portal image also implies a vendor's market engagement, and such intentions can affect consumers' evaluation of the competence and sincerity of the vendor (Hosany et al., 2006, Murphy et al., 2007). Taken together, we hypothesize that:

***H2a: The aesthetics of the portal image for a service offering is positively associated consumers' perception of service quality.***

***H2b: Consumers' perception of service quality is positively associated with their purchase decisions.***

While pleasing visual stimuli can elicit positive outcomes, such impact tends to vary across cultures (Cyr et al., 2009) and individuals (Hartmann et al., 2007, Wang et al., 2013, Vieira, 2010) due to cultural and personal discrepancies in one's preference for visuals. Specifically, consumer's centrality for visual aesthetics can significantly alter the ability of aesthetics to stimulate both consumers' cognitive responses and emotional states (Bloch et al., 2003, Vieira, 2010, Yoo and Kim, 2014).

Consumers' centrality of visual aesthetics can influence their reactions to image aesthetics in three ways. First, a consumer who places great emphasis on visual aesthetics tends to interpret a service offering with decent images as being more valuable and having greater quality (Park and Ha, 2016), extracting higher levels of pleasure from appreciating beautiful images (Seifert, 2011). Second, the acumen aspect of aesthetic centrality defines consumers' capacity to recognize and assess the design elements of a service image (Bloch et al., 2003). Specifically, a discerning consumer can formulate more concrete quality perception of the service by retrieving information from the portal image (Bloch and Kamran-Disfani, 2018), while the consumer's acumen in acknowledging the beauty of a service visualization also bolsters the feelings of dominance during the decision-making process (Lin, 2016). Lastly, consumers' centrality towards aesthetical design shapes their emotional arousal toward the service image (Yoo and Kim, 2014), and amplifies their elaboration in processing the information cues revealed in the service offering (Vieira, 2010). In sum, the three mechanisms of the centrality of visual aesthetics namely, value, acumen, and response, would determine the extent to which image aesthetics of a service deal can exert an influence on consumers' cognitive and emotional responses. We therefore hypothesize that:

***H3: Consumers' centrality of visual aesthetics reinforces the impact of the aesthetics of the portal image for a service offering on their level of emotional states.***

***H4: Consumers' centrality of visual aesthetics reinforces the impact of the aesthetics of the portal image for a service offering on their perception of service quality.***

## **4 Methodology**

We plan to validate our research model based on data gathered from Lashou.com, a leading group-buying site in China that focuses on the promotion and sales of localized services. Specifically, we ran a script to collect data on a daily basis for 16 months between 2012-07-14 and 2013-11-14. The data contains service attributes (e.g. portal image) and transactional details for over 299,000 localized services offerings. Next, we employ deep learning to assess the aesthetics of the portal image for each service offering before utilizing Propensity Score Matching (PSM) to analyze the effectiveness of machine-annotated aesthetics score in predicting the online sales of services. Initial evidence reveals a significant effect of aesthetics on the online sales of service. We then outline an experimental setting for ascertaining the causality of the hypothesized relationships in which the proposed deep learning technique could serve as the basis for selecting portal images to be employed in the experiment.

### **4.1 Image Aesthetics Ranking Network**

We implemented the deep Convolutional Neural Network (CNN) method to evaluate the aesthetics of the portal images of service deals based on 11 photographic attributes that constitute the core drivers of photo aesthetics (Kong et al., 2016). The CNN is built upon the AlexNet front-end architecture (Krizhevsky et al., 2012) with the addition of an attribute predictor branch to the aesthetic branch to



output a final attribute-adapted aesthetic score. The photographic attributes employed in the attribute-adaptation schema are shown in Figure 2. The network is pre-trained on a large-scale Aesthetics and Attributes Database (AADB) consisting of 10,000 images with human evaluations on the overall aesthetics and the selected 11 photographic attributes. We initialize the network using a GPU machine with 8 TITAN Xp GPUs (12GB memory for each) and produce the overall aesthetic quality ratings (range from 0 to 1) along with the 11 attribute assignments (range from -1 to 1) for all service images. Figure 2 depicts two groups of service images with the aesthetic evaluations produced by the CNN-based algorithm. In line with Kong et al. (2016), we deem an image attribute positively contributes to the overall aesthetics if its rating is above 0.2 whereas negatively affects aesthetics if its rating is below 0.2. Attributes with assignments between -0.2 and 0.2 are conceived to be insignificant aesthetic features. We then highlight the positive (green tick) and negative (red cross) dimensions of aesthetics for each image. To further verify the reliability of the algorithm, we randomly selected 100 images from our dataset and hired two coders to manually check the ratings of each aesthetical dimension. The results indicated that the derived ratings can achieve over 75% of accuracy with high human consistency (rate correlation between the two coders is 0.78). Overall, the examples and our preliminary validation illustrate the effectiveness of the implemented aesthetic evaluation algorithm.

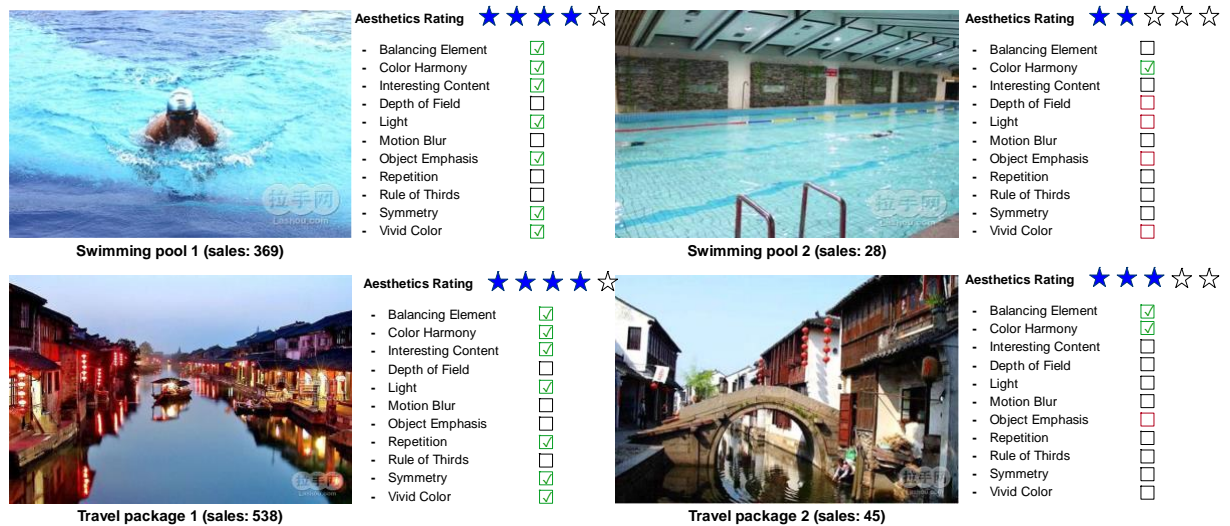


Figure 2. Examples of estimated scores on aesthetics and determining attributes (city, price, and discount were controlled).

## 4.2 Image Aesthetics and Online Sales of Services: A Pre-Test

Before testing individual’s response on the aesthetics of service images, we validated the effectiveness of image aesthetics at a collective level by performing Propensity Score Matching (PSM) (Austin, 2011) to scrutinize how image aesthetics could drive the online sales of services. PSM has been increasingly employed to estimate the “treatment effect” of a focal variable by mimicking the basic settings of randomized experiments (Austin, 2011). Particularly, PSM allows us to estimate the impact of image aesthetics on online sales of services by creating propensity scores to account for the systematic differences in baseline covariates that could determine vendors’ selection of including an appealing portal image on their deals. A logit model was performed by selecting days of sale (*Dateofsale*), service price (*LnPrice*), discount (*Discount*), length of the title (*LnTitleLen*) and description (*LnIntroLen*), city, and service type as covariates. We conduct PSM on each service category separately to control other potential covariates related to the nature of the service offering (e.g., the content of the services and their portal images). A service is deemed as *High\_Aesthetic/Low\_Aesthetic* if the aesthetic score of its portal image is two standard deviations higher/lower than the average aesthetic score of images of all services of the same type. Consequently, 15,420 services were selected into the optimal matching procedure (Caliendo and Kopeinig, 2008).



The statistics of the covariates of the matched samples as well as their aesthetic scores and sales are summarized in Table 1. The *t*-test results demonstrate that there are no significant differences of all covariates between the two groups after matching. Moreover, the average sales of the services with aesthetically pleasing portal images is two times higher than that of the counterparts with less appealing images, demonstrating the importance of image aesthetics in the service E-tailing setting.

Variable	Low_Aesthetic (N=5899)		High_Aesthetic (N=5853)		P-value of t-test
	mean	std	mean	std	
<i>Dateofsale</i>	0.153	1.015	0.154	0.960	0.681
<i>LnPrice</i>	4.002	1.244	4.018	1.165	0.194
<i>Discount</i>	0.630	0.223	0.623	0.224	0.249
<i>LnTitleLen</i>	5.111	0.377	5.171	0.408	0.238
<i>LnIntroLen</i>	0.716	1.556	0.731	1.834	0.223
<i>Aesthetic Score</i>	0.394	0.052	0.744	0.049	0.000
<i>Average Sales</i>	21.646	1.724	43.256	1.762	0.000

Table 1. Statistics and covariate comparison after performing PSM.

### 4.3 Future experimental settings

Though our preliminary results attest to the role of image aesthetics in driving sales of a service deal, further exploration is needed to articulate whether the mechanisms an individual consumer undergoes in processing service images is aligned with the proposed S-O-R framework and if a consumer’s centrality of visual aesthetics would have a moderating influence. Accordingly, we plan to conduct an online experiment by constructing an experimental mock-up of an online service-buying environment and recruit participants to make hypothetical purchase decisions on multiple sets of service offerings with distinct portal images (e.g. by varying the level of aesthetics of each image). After presenting each choice set, participants will answer questions about their service quality perception (Lee et al., 2000), and their evaluations on the level of the three dimensions of emotional states (Mehrabian and Russell, 1974) when viewing each portal image. Besides, we subscribe to Lindgaard et al.’s (2011) measurement on trust to capture participants’ trusting beliefs on each service deal since trust could be a core driver of perceived quality and has been documented to be associated with visual aesthetics in prior studies (Li and Yeh, 2010, Ashraf and Niazi, 2018, Ganguly et al., 2010). After the experiment, participants will be directed to an online questionnaire that measures their centrality of visual aesthetics (Vieira, 2010), service involvement (McQuarrie and Munson, 1992), and service knowledge (Smith and Park, 1992), where the latter two will serve as control variables.

## 5 Expected Contributions

This study contributes to service e-tailing and visual design research on two fronts. First, complementing prior research that allude to the persuasiveness of aesthetics on website design (Jiang et al., 2016), our study elevates this awareness to examine the effect of beautiful portal images in the service e-tailing context. We synthesize extant literature on the role of visual cues in alleviating the uncertainty consumers encounter when evaluating intangible service offerings and subscribe to S-O-R framework to construct a research model whereby image aesthetics is posited to galvanize consumers’ cognitive responses and emotional states in shaping their purchase decisions. Second, we draw on deep learning technique to show how image aesthetics can be automatically evaluated on an extensive scale. As the first step to articulate individuals’ response to image aesthetics, we leverage on such machine-annotated aesthetic score to uncover how the collective sales of services can be boosted by offering appealing portal image. By testifying to the effectiveness of the deep learning techniques, our work not only offers actionable methods to assist service vendors to beautify the online portal images of their services, but it can guide practitioners in structuring images to improve their marketing performance.

## References

- An, D. (2014). "Tangibilizing services through visual tangible cues in corporate web sites: A six-country cross-cultural analysis." *Journal of Services Marketing* 28(7), 566-579.
- Animesh, A., Pinsonneault, A., Yang, S.-B. & Oh, W. (2011). "An odyssey into virtual worlds: Exploring the impacts of technological and spatial environments on intention to purchase virtual products." *Mis Quarterly* 789-810.
- Austin, P. C. (2011). "An introduction to propensity score methods for reducing the effects of confounding in observational studies." *Multivariate behavioral research* 46(3), 399-424.
- Azimi, J., Zhang, R., Zhou, Y., Navalpakkam, V., Mao, J. & Fern, X. (Year). Published. The impact of visual appearance on user response in online display advertising. Proceedings of the 21st International Conference on World Wide Web, 2012. ACM, 457-458.
- Bell, S. J. (1999). "Image and consumer attraction to intraurban retail areas: An environmental psychology approach." *Journal of Retailing and Consumer services* 6(2), 67-78.
- Bloch, P. H., Brunel, F. F. & Arnold, T. J. (2003). "Individual differences in the centrality of visual product aesthetics: Concept and measurement." *Journal of consumer research* 29(4), 551-565.
- Bloch, P. H. & Kamran-Disfani, O. (2018). "A framework for studying the impact of outdoor atmospherics in retailing." *AMS Review* 1-19.
- Caliendo, M. & Kopeinig, S. (2008). "Some practical guidance for the implementation of propensity score matching." *Journal of economic surveys* 22(1), 31-72.
- Chang, S.-H., Chih, W.-H., Liou, D.-K. & Hwang, L.-R. (2014). "The influence of web aesthetics on customers' pad." *Computers in Human Behavior* 36(168-178).
- Creusen, M. E., Veryzer, R. W. & Schoormans, J. P. (2010). "Product value importance and consumer preference for visual complexity and symmetry." *European Journal of Marketing* 44(9/10), 1437-1452.
- Crilly, N., Moultrie, J. & Clarkson, P. J. (2004). "Seeing things: Consumer response to the visual domain in product design." *Design studies* 25(6), 547-577.
- Cyr, D., Head, M., Larios, H. & Pan, B. (2009). "Exploring human images in website design: A multi-method approach." *MIS quarterly* 539-566.
- Deng, L. & Poole, M. S. (2010). "Affect in web interfaces: A study of the impacts of web page visual complexity and order." *Mis Quarterly* 711-730.
- Ding, Y. & Keh, H. T. (2017). "Consumer reliance on intangible versus tangible attributes in service evaluation: The role of construal level." *Journal of the Academy of Marketing Science* 45(6), 848-865.
- Eroglu, S. A., Machleit, K. A. & Davis, L. M. (2001). "Atmospheric qualities of online retailing: A conceptual model and implications." *Journal of Business research* 54(2), 177-184.
- Fiore, A. M., Yah, X. & Yoh, E. (2000). "Effects of a product display and environmental fragrancing on approach responses and pleasurable experiences." *Psychology & Marketing* 17(1), 27-54.
- Ganguly, B., Dash, S., Cyr, D. & Head, M. M. (2010). "The effects of website design on purchase intention in online shopping: The mediating role of trust and the moderating role of culture." *International Journal of Electronic Business* 8(4), 302-330.
- Grove, S. J., Carlson, L. & Dorsch, M. J. (2002). "Addressing services' intangibility through integrated marketing communication: An exploratory study." *Journal of services marketing* 16(5), 393-411.
- Hartmann, J., Sutcliffe, A. & De Angeli, A. (Year). Published. Investigating attractiveness in web user interfaces. Proceedings of the SIGCHI conference on Human factors in computing systems, 2007. ACM, 387-396.
- Hill, D. J., Blodgett, J., Baer, R. & Wakefield, K. (2004). "An investigation of visualization and documentation strategies in services advertising." *Journal of Service Research* 7(2), 155-166.
- Hooper, D., Coughlan, J. & R. Mullen, M. (2013). "The servicescape as an antecedent to service quality and behavioral intentions." *Journal of services marketing* 27(4), 271-280.

- Hosany, S., Ekinci, Y. & Uysal, M. (2006). "Destination image and destination personality: An application of branding theories to tourism places." *Journal of business research* 59(5), 638-642.
- Jiang, Z., Wang, W., Tan, B. C. & Yu, J. (2016). "The determinants and impacts of aesthetics in users' first interaction with websites." *Journal of Management Information Systems* 33(1), 229-259.
- Kim, J. & Lennon, S. J. (2013). "Effects of reputation and website quality on online consumers' emotion, perceived risk and purchase intention: Based on the stimulus-organism-response model." *Journal of Research in Interactive Marketing* 7(1), 33-56.
- Kim, M. & Lennon, S. (2008). "The effects of visual and verbal information on attitudes and purchase intentions in internet shopping." *Psychology & Marketing* 25(2), 146-178.
- Kong, S., Shen, X., Lin, Z., Mech, R. & Fowlkes, C. (Year). Published. Photo aesthetics ranking network with attributes and content adaptation. European Conference on Computer Vision, 2016. Springer, 662-679.
- Krizhevsky, A., Sutskever, I. & Hinton, G. E. (Year). Published. Imagenet classification with deep convolutional neural networks. Advances in neural information processing systems, 2012. 1097-1105.
- Lavie, T. & Tractinsky, N. (2004). "Assessing dimensions of perceived visual aesthetics of web sites." *International journal of human-computer studies* 60(3), 269-298.
- Lee, H., Lee, Y. & Yoo, D. (2000). "The determinants of perceived service quality and its relationship with satisfaction." *Journal of services marketing* 14(3), 217-231.
- Li, Y.-M. & Yeh, Y.-S. (2010). "Increasing trust in mobile commerce through design aesthetics." *Computers in Human Behavior* 26(4), 673-684.
- Lin, I. Y. (2016). "Effects of visual servicescape aesthetics comprehension and appreciation on consumer experience." *Journal of Services Marketing* 30(7), 692-712.
- Lindgaard, G., Dudek, C., Sen, D., Sumegi, L. & Noonan, P. (2011). "An exploration of relations between visual appeal, trustworthiness and perceived usability of homepages." *ACM Trans. Comput.-Hum. Interact.* 18(1), 1-30.
- Lorenzo-Romero, C., Constantinides, E. & Alarcón-del-Amo, M.-d.-C. (2013). "Web aesthetics effects on user decisions: Impact of exposure length on website quality perceptions and buying intentions." *Journal of internet commerce* 12(1), 76-105.
- Lupyan, G. & Spivey, M. J. (2010). "Making the invisible visible: Verbal but not visual cues enhance visual detection." *PloS one* 5(7), e11452.
- McQuarrie, E. F. & Munson, J. M. (1992). "A revised product involvement inventory: Improved usability and validity." *ACR North American Advances*.
- Mehrabian, A. & Russell, J. A. (1974). "The basic emotional impact of environments." *Perceptual and motor skills* 38(1), 283-301.
- Miller, D. W. & Foust, J. E. (2003). "Classifying services by tangibility/intangibility of attributes and benefits." *Services Marketing Quarterly* 24(4), 35-55.
- Moriya, J. (2018). "Visual mental imagery influences attentional guidance in a visual-search task." *Attention, Perception, & Psychophysics* 1-16.
- Mosteller, J., Donthu, N. & Eroglu, S. (2014). "The fluent online shopping experience." *Journal of Business Research* 67(11), 2486-2493.
- Mowen, J. C., Fang, X. & Scott, K. (2010). "Visual product aesthetics: A hierarchical analysis of its trait and value antecedents and its behavioral consequences." *European Journal of Marketing* 44(11/12), 1744-1762.
- Murphy, L., Moscardo, G. & Benckendorff, P. (2007). "Using brand personality to differentiate regional tourism destinations." *Journal of travel research* 46(1), 5-14.
- Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1985). "A conceptual model of service quality and its implications for future research." *the Journal of Marketing* 41-50.
- Park, J. & Ha, S. (2016). "Co-creation of service recovery: Utilitarian and hedonic value and post-recovery responses." *Journal of Retailing and Consumer Services* 28(3)10-316.
- Porat, T. & Tractinsky, N. (2012). "It's a pleasure buying here: The effects of web-store design on consumers' emotions and attitudes." *Human-Computer Interaction* 27(3), 235-276.

- Seifert, C. (2011). "The effects of design complexity and novelty on aesthetic response: The moderating role of centrality of visual product aesthetics."
- Sheng, M. L. & Teo, T. S. (2012). "Product attributes and brand equity in the mobile domain: The mediating role of customer experience." *International Journal of Information Management* 32(2), 139-146.
- Smith, D. C. & Park, C. W. (1992). "The effects of brand extensions on market share and advertising efficiency." *JMR, Journal of Marketing Research* 29(3), 296.
- Stafford, M. R. (1996). "Tangibility in services advertising: An investigation of verbal versus visual cues." *Journal of Advertising* 25(3), 13-28.
- Van der Heijden, H. (2004). "User acceptance of hedonic information systems." *MIS quarterly* 695-704.
- van Enschot, R. & Hoeken, H. (2015). "The occurrence and effects of verbal and visual anchoring of tropes on the perceived comprehensibility and liking of tv commercials." *Journal of Advertising* 44(1), 25-36.
- Vieira, V. A. (2010). "Visual aesthetics in store environment and its moderating role on consumer intention." *Journal of Consumer Behaviour* 9(5), 364-380.
- Vilnai-Yavetz, I. & Rafaeli, A. (2006). "Aesthetics and professionalism of virtual servicescapes." *Journal of Service Research* 8(3), 245-259.
- Vilnai-Yavetz, I. & Tifferet, S. (2009). "Images in academic web pages as marketing tools: Meeting the challenge of service intangibility." *Journal of Relationship Marketing* 8(2), 148-164.
- Wang, Hernandez, M. D. & Minor, M. S. (2010). "Web aesthetics effects on perceived online service quality and satisfaction in an e-tail environment: The moderating role of purchase task." *Journal of Business Research* 63(9-10), 935-942.
- Wang, Minor, M. S. & Wei, J. (2011). "Aesthetics and the online shopping environment: Understanding consumer responses." *Journal of Retailing* 87(1), 46-58.
- Wang, Y. J., Cruthirds, K. W., Axinn, C. N. & Guo, C. (2013). "In search of aesthetics in consumer marketing: An examination of aesthetic stimuli from the philosophy of art and the psychology of art." *Academy of Marketing Studies Journal* 17(2).
- Xu, J. D., Benbasat, I. & Cenfetelli, R. T. (2014). "The nature and consequences of trade-off transparency in the context of recommendation agents1." *MIS quarterly* 38(2).
- Yoo, J. & Kim, M. (2014). "The effects of home page design on consumer responses: Moderating role of centrality of visual product aesthetics." *Computers in Human Behavior* 38, 240-247.
- Zhang, H., Sun, J., Liu, F. & G. Knight, J. (2014). "Be rational or be emotional: Advertising appeals, service types and consumer responses." *European Journal of Marketing* 48(11/12), 2105-2126.
- Zhang, P. (2013). "The affective response model: A theoretical framework of affective concepts and their relationships in the ict context." *MIS quarterly* 247-274.
- Zhang, S., Lee, D., Singh, P. V. & Srinivasan, K. (2017). "How much is an image worth? Airbnb property demand estimation leveraging large scale image analytics." *Working paper*.