

Hidden power of affective products and environments

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Abstract.

BACKGROUND: Designs that evoke fun and surprise have been successful in driving uncommon positive behavior. Affective design (AD) is based on the premise that products and services can elicit strong affective responses that can be harnessed for specific purposes such as increasing consumption.

OBJECTIVE: This paper aims to discuss the theoretical foundations and applications of AD to address contemporary consumption, recycling, and healthcare issues.

METHODS: Current applications of AD to address environmental and health issues were analyzed in terms of effectiveness in changing user behavior. Relevant concepts were used to provide future research directions in this field.

RESULTS: Early applications of AD focused on designing products to increase customer satisfaction and stimulate consumption. The method, however, is auspicious in solving relevant societal and global problems. To pave the way for successful integration of AD, one research direction is the need to identify the right emotion to elicit in a certain context. There is a dearth of literature to promote sustainable consumption, such as using less energy, minimizing carbon footprint, or just taking care of the environment using AD.

CONCLUSION: The integration of AD is a strategy that can be used to prompt behavior beneficial to society and the environment. Literature on AD suggests that a deliberate effort to manipulate design factors can work to elicit strong affective responses.

Keywords: Affective design, sustainability, Kansei engineering, ergonomics in design, product design

1. Introduction

Designers have used the power of emotion to direct people's behavior in various contexts. The success of the piano stairs and the world's deepest trash bin (WDTB) in using fun to attract and encourage repeated experience is a testament to this hidden power [1, 2]. It is typical behavior to take the least difficult path, such as using an escalator over a flight of stairs or leaving trash around over putting it in a trash bin. But given a different perspective, the more difficult or unpopular alternative can be preferred.

The success of both products can be attributed to the integration of novelty and fun into the design. The piano stairs appealed to people's interest for music

and the desire to experience something new [2]. The actual experience was surprising and fun - causing them to repeat and relish the experience. Surprise, curiosity, and fun also drove people to throw trash inside the WDTB that emits a sound implying a long journey of the trash to the bottom of the bin. Users who threw trash were observed listening carefully to the sound and threw trash repeatedly to investigate the phenomenon. The curiosity did not stop there as they were even observed spreading the "news" to friends and colleagues so they could also try it. As a result, the bin was able to collect 72 kg of trash in a day, which is way beyond the normal trash collection in that area. The fun elicited by the experience could have prompted the excitement to share the experience

with others who were affected in the same way by the design. The concept of the WDTB can be applied to prevent littering in places where the trash generated is likely to end at as litter such as school grounds, parks, shopping centers, and beaches.

It can be inferred from these examples that specific emotions can be designed into a product or environment and the careful identification of this emotion is integral for desired behavioral change. This paper aims to discuss the theoretical foundations and application of affective design (AD) to address contemporary consumption, recycling, and health-care issues. Research issues that can be addressed in the future are also outlined.

2. Affective responses in consumption

AD is based on the premise that products and environments are capable of eliciting strong affective responses that can be exploited for specific purposes. Norman [3] asserted that consumers tend to disregard a product's shortcomings if it evokes positive affect. Affect is defined as "an intense and relatively short emotional state brought about by a sudden change in any circumstances vital for the person or animal" [4]. It is sudden and involuntary, typical of encounters with novel and interesting products that arouse awe, curiosity, and desire. Affects can be prompted by product characteristics such as shape or form [5, 6], environmental attributes such as color, size, and curves [7], performance features [8], aesthetic quality [9], or brand [10]. The human desire for pleasure and individuation justifies the need to design products beyond functionality and usability [11, 12]. Creating products that create emotional experiences has become a strategy to gain a competitive advantage [13]. However, AD goes beyond creating products for pleasure. A range of emotions can be considered to achieve a design purpose. Negative affect can also be useful in curbing consumption, especially in the context of sustainability.

Consumer emotional response varies throughout the consumption stages. The pre-purchase stage involves searching and doing a cursory evaluation of the product. This stage ends with a decision to either abandon or purchase a product. The post-purchase stage is contingent on a positive purchase decision after evaluation. The pre-purchase affect set consists of emotion words related to attraction, consideration, and satisfaction that are mostly positive [14]. The consumption emotion set (CES) proposed by

Richins [15] includes negative emotions that may be derived from post-purchase experiences such as sadness, misery, and hopelessness. These emotion sets were found to be relevant in the process of measuring emotion intensity especially in the context of evaluating design alternatives.

The experience of affect in the pre-purchase context is more pronounced for high-involvement products. These products are considered personal and matter most to the user such as gadgets, vehicles, and items of clothing. They are used mainly by the owner and have the potential to show individuality. Better designs of these products generate positive reactions from the user, such as inspiration and joy [16]. The uniqueness afforded by the product to the user is the source of pleasure and translates into attachment - a sentiment developed from repeated positive experiences of the product. There are many instances when the product is not perfect but is evaluated positively by the user. Products that comply with the user's goal usually cause strong attachment that starts with feelings of positive emotion that need to be relished by using the product as many times as possible. Some people refer to their cars as partners, while one female author finds happiness in riding her old car because of the pride brought about by its unique shape and design.

3. Affective design models and methods

The Multilayered Model of Product Emotion (MMPE) provided a theoretical basis for emotional responses to products categorized as instrumental, aesthetic, social, surprise, and interest [17]. The model asserts that emotional response is generated by product appraisal in terms of novelty, motive compliance, intrinsic pleasantness, legitimacy, and challenge. These appraisal criteria were brought about by a concern related to a goal, attitude, or standard. One home maker's concern, for example, is to prepare food efficiently. Thus, kitchen gadgets that comply with this motive engender surprise emotions that can be pleasant or unpleasant depending on the product's adherence to the concern. A food processor's promise of faster food preparation generates positive emotions such as hope or delight. However, the actual experience can turn unpleasant if usability, performance, and reliability problems are encountered.

Prior to the MMPE, the Kansei Engineering (KE) method had already been applied as a method for

translating a customer's psychological feeling (Kansei) into the design and function of a product [18]. Kansei is obtained from interviews or observations of customers. A target Kansei or a concept is broken down until a final kansei is reached that can be directly linked to design elements related to form and other sensory characteristics [18–20]. The method has been used widely in the automotive, electric home appliance, office machine and construction industries [18]. Recent applications were in social robot design [21], service design [22], and customer trust [23].

A similar method called Citarasa Engineering (CE) used emotional intent to integrate emotion in design [24]. Citarasa is characterized by a strong desire that prompts the user to actively search for specific design features in high-value products such as cars, trucks, and kitchens. Unlike KE, which is based on the customer's sensory experience, CE is driven by strong desire and intention that is evaluated using the affective and cognitive experience of the user [25].

KE was also used in conjunction with Quality Function Deployment (QFD) to simultaneously determine design attributes setting and engineering requirements that are usually done separately [26]. The application of this methodology produced higher customer satisfaction compared with the standalone QFD and standalone AD methods.

KE, CE, and QFD are formal design methods that have been widely used in the industry. A range of specific affective responses or emotional intents is used in the design process to achieve customer satisfaction and drive up sales. However, there are many studies in AD literature that mainly aim to promote pleasurable use and experience of other positive emotions [27, 28].

Although AD had been widely and successfully used to increase consumption and enhance satisfaction, its use had been very limited in promoting altruistic objectives. Emotional experience can be powerful enough to incite a change in behavior, and its potential can be utilized to address some of the published UN sustainable development goals (SDGs).

4. Designing for sustainability

Resource depletion and waste generation are problems that plague the world, and current sustainability solutions do not work due to the gap between intention and action. A strong willingness to recycle does not translate to actual recycling in China, where only 2% of municipal waste is recycled [29]. People con-

cerned about the environment and energy futures do not take steps to change their behavior to address energy shortages or global warming [30]. Recyclers and non-recyclers did not differ in their attitudes toward recycling. The self-interest of people prevails over the concern for the environment. Action is mainly influenced by economic and convenience motives [31, 32].

Many countries have invested in recycling programs to curb waste and minimize resource depletion. Most research on sustainability practices focuses on recycling [33]. One of the main problems in recycling, however, is the low participation rate in the general population. The recycling and composting rates in the US only reached 32% in 2018 [34] and it is unlikely that the 50% recycling rate was achieved in England by 2020 [35]. Recycling in the construction industry has not been successful because the positive attitude towards recycling is overshadowed by the weak behavior of the practitioners [36]. Moreover, not all materials for recycling get recycled. Only 9% of plastics have been recycled, and around 79% end up in landfills or litter the environment [37]. Thus, the more logical way to control waste is to minimize consumption and promote product reuse.

4.1. Consumption reduction

One way to limit consumption is to promote the long-term use of durable products by examining the emotional connection between products and consumers and the drivers of this connection. Emotionally Durable Design (EDD) promotes product longevity using this approach [38, 39]. EDD runs counter to the concept of "planned obsolescence" when a product is designed to have a short life so consumers can do repeat purchases [40]. People discard products because of change in trend or degradation of function. However, waste can be minimized if products can be durable and reliable while considering consumers' affective needs.

Design for product attachment is very prominent in the literature on emotional longevity. Haines-Gadd, Chapman [39] enumerated several vital strategies for promoting product attachment based on previous research, including nostalgia, pleasure, enjoyment, self-expression, and usability. Schifferstein and Zwartkruis-Pelgrim [41] found that the attachment created by pleasure is usually short-lived, so pleasure-eliciting attributes should be exclusive for a particular product variant. Customers tend to enjoy products that evoke surprise, although this state does not last

for a long time [42]. However, the experience of surprise creates a heightened awareness of the product that facilitates memory creation [13]. Products that are used to express one's personal identity gain special meaning for the owner either because of their color, form, or the memories built through years of use [13, 43].

Although design for attachment seems to be a promising method for circular economy, there is limited detail on its application [39]. EDD was tested to design a kettle - a typical kitchen appliance that people do not usually get attached to. The designers enhanced the relationship between the users and the product by making it unique and expressive. The kettle expressed itself by revolving around its own axis and was named Sneaky Kettle [44]. It rotates on its base two days after purchase, and this feature caused the users to boil more water to observe its behavior. The development of involvement and interest in Sneaky Kettle made it difficult for owners to readily replace it before its intended useful life when new models appeared in the market. The memorable experiences with the Sneaky Kettle become conversation topics for the owners.

In products that are expected to last for a long time, the impression of durability is related to willingness to keep. However, aesthetic impressions are associated with attachment [45]. Products designed for attachment, therefore, must have a reasonably long life to achieve the purpose of reducing consumption. People are highly attached to their gadgets, but the flimsy design prompts early replacement.

In terms of non-durable goods, paper and paper boards are the leading concern in waste management. It is the top component of solid waste in the US and comprised 11.78% of landfills in 2018 [34]. The sheer volume of paper waste production makes it a good candidate for recycling or reusing. A big component of paper waste includes packaging materials that people do not reuse and easily discard because of their diminished value after consumption. AD literature showed that consumer behavior could be influenced by product design features, as illustrated in the following case studies.

The fashion industry is one of the biggest users of paper packaging due to the rapid growth in the global demand for apparel [46]. Shopping paper bags are among the most sought-after types of shopping bags aside from plastic shopping bags [47]. Retailers design the shopping bags to make them attractive to be reused and promote their brand. However, most of these shopping bags still end up too early in the

trash bins. Balasbas, Co [48] addressed the problem of recycling by considering the AD features of shopping paper bags such as color, shape, and print. Results of the study suggest that the color and pattern of the shopping paper bag significantly influenced recycling behavior. Kraft paper bags are perceived to have low quality because they are common and flimsy. In contrast, colored shopping bags, especially those corresponding to users' tastes, are likely to be reused because they are perceived as beautiful, elegant, and unique. Therefore, retailers should consider these two affective attributes in making design decisions for packaging their products for business and sustainability reasons.

Some retail stores encourage sustainable behavior by encouraging customers to bring their own shopping bags. They either sell them, give them away, and/or offer incentives to those who bring their own bags [49]. Ecologically-friendly bags, commonly known as eco-bags, has become a fashion eco-trend in Korea, where trendsetters use them more than luxury bags to show their concern for the environment [50]. Eco-bags also drew significant attention from consumers because of the negative effects of single-use plastic (SUP) bags. However, the ownership of eco-bags does not translate to its actual use. In the UK, 94% of citizens own a reusable eco-bag, but around 31% have unused ones at home. About one in four continue to buy reusable bags when they shop, and about 11% do this regularly [51].

The reasons behind the piling up of eco-bags at home have not been tackled much in literature. With the potential of being a fashion item, Aguilar, Bascos [6] investigated the affective characteristics of eco-bags: color, form, and material on product attachment. Only 59% of participants kept and used the eco-bags given to them after a masked experiment. Results also showed that the color and texture of the bag material significantly influence attachment. The bag's color can represent the user's identity, and even if a white bag can quickly accumulate dirt, users are still willing to use it because of color preference. Since eco-bags are expected to be folded, kept, and reused, the material of the eco-bag had a significant effect on the decision to save and reuse. Cloth eco-bags were preferred over plastic eco bags because they are gentle to the skin and easy to fold and keep. People who did not keep the eco-bags received already had a favorite eco-bag that catered to their taste.

It is apparent that the progress of recycling and waste reduction initiatives lies in understanding

human motives, limitations, and biases, among others. The desire for pleasurable and positive affective experiences can be channeled to good behavior by design. The driver of these desires requires careful investigation to achieve intended design outcomes.

4.2. Waste Management

AD can also be used to encourage pro-social behaviors that promote sustainability, such as waste segregation - a global challenge in waste management due to lack of participation in government programs. Proper separation of materials is a requisite to successful recycling programs since the process becomes more efficient [52]. Some of the barriers to waste segregation identified in a Thai community include apathy, poor communication, negative attitudes, and lack of awareness, to name a few [53].

The issue of poor communication was effectively addressed by signages promoting recycling and proper trash disposal [54]. However, there is limited literature on waste disposal signs, especially signage design factors and their effect on attention and understanding [55]. Signage can promote certain behaviors by using a message meant to elicit strong emotions. Fear appeals, for example, have been used in cigarette packaging to dissuade people from smoking.

Signages had been used to improve waste disposal in Thailand, but people just ignored them [53]. This behavior can be attributed to the signage design that only included the statement "Please do not litter," which is commonplace and does not create an emotional impact. Wu, Lenkic [55] showed that the inclusion of icons or pictures improved waste disposal compared to just plain text. The images enhanced the appeal of the signage, prompting people to pay attention to its message and cooperate. The use of motivational signs containing messages and graphics increased waste disposal in a music festival but not the proper segregation of waste [56].

Mallett [57] found that college students who are reminded of environmental standards are likely to engage in behavior to protect the environment. Dy, Lazo [58] integrated affect in the design of a poster to influence participants' intention to segregate waste in a university. The signage designed aimed to evoke guilt because eco-guilt is associated with behavioral intentions that protect the environment despite individual differences in pro-environmental attitudes [57]. A photo of a child swimming in waste was used together with a guilt-evoking statement such as "Your failure to segregate trash contributes to the pollu-

tion of our waters." Results showed that the intention to segregate was significantly affected by the guilt elicited by the signage. The response was mediated by the clarity of the message as the respondents had to understand the context of the sign. The photo included in the signage made them realize the impact of their actions towards others and the environment. Good quality photos were also found useful in communicating the message better to the intended audience.

Signages meant to encourage environmental care and protection work better when attractive images that embody the right emotion are used to facilitate communication of the message. Mere words are not enough to capture the viewer's attention and persuade people to act appropriately.

4.3. Health promotion and disease control

Since the COVID-19 pandemic began, one of the main challenges has been making people follow health protocols to prevent the spread of disease. The barriers involved in protecting one's health and others overshadow the perceived benefits of following the protocols [59]. People with a strong sense of entitlement are less likely to engage in social distancing and handwashing [60]. Personality traits were also associated with the likelihood of engaging in health-related behaviors [61].

One of the most effective ways to mitigate the risk of influenza in the workplace is hand hygiene [62]. Hand hygiene practice in hospitals is not complied with 100% of the time [63] and the rate is even worse in non-hospital settings such as offices [64], schools [65], and workplaces [66].

Leaflets and posters were found not to affect the knowledge and attitudes of school-aged children [67] nor did they affect the behavior of hospital personnel if not strategically located [68]. However, a poster carefully designed to be attractive, memorable, and invoking thoughts of infecting vulnerable people influence the intention to follow desirable health protocols such as social distancing [69]. The poster had been effective in explaining distinctly the importance of avoiding infection in a way that resonated with the viewers. The design allowed them to relate to the situation by putting images of real people that they could likely relate with.

In a related study, the human 'disgust' factor was used to design a poster to influence hand hygiene practice and compliance in a university setting [70]. Disgust was used based on its effectiveness in promoting handwashing using a video-based inter-

vention. The poster used an image of a dirty hand highlighting the microbial growth when not washed properly together with a message on the effect of good hand hygiene. The design, however, only caused a slight increase in compliance that is not statistically significant compared to the status quo. The insignificant result can probably be attributed to the choice of the right affective response to elicit or the choice of picture and message in the poster. Disgust does not encourage pro-social behavior, unlike guilt earlier used by Lunn, Timmons [69]. The image showed a few microbes on a dirty hand, so it was not compelling enough to promote compliance.

Although the effect of posters in promoting healthy behaviors is difficult to determine [68], the prospect of using AD seems promising. Signs that were ineffective in changing behavior did not judiciously use pictures and messages to elicit specific emotions appropriate for the situation. Several studies indicate that affective states influence decision-making and behavior [71–73]. The design of posters and other communication can carefully investigate affective attributes such as color, image, size, length of the message, message framing, font, layout, etc., to realize a distinct emotion to engender a certain behavior.

5. Future research directions in affective design

Early applications of AD focused on designing products to increase customer satisfaction and stimulate consumption. As illustrated in the earlier discussion, there has been limited diversity in applying AD in other design contexts in the last ten years. The method, however, is auspicious in solving relevant societal and global problems such as the attainment of the United Nations Sustainable Development Goals 3 (Good health and well-being), 11 (Sustainable cities and communities), and 12 (Responsible consumption and production). The 2020 SDG report highlighted the unavailability of handwashing facilities in the least developed countries (LDC) [74] to address COVID-19 infection. Still, it did not mention a low handwashing compliance rate even in developed countries with adequate facilities. Barriers in attaining health goals, therefore, are not only a matter of poverty but also of active participation. Conventional techniques to promote compliance do not work as intended. AD is a promising alternative as it uses the tendency of people to be attracted to things they like or are drawn to. The

only possible challenge in the use of this technique is the deliberate understanding of how people behave and what will appeal to them. The design process can take a lot of time because it will be based not only on function but on a design that will appeal to their sense of responsibility and other behavior that needs to be developed.

The same report also recognized the fast-growing volume of waste driven by the increasing electronic and electrical equipment consumption. In 2019, e-waste reached 7.3 kilograms per capita annually. Disposal of packaging also grew due to the popularity of online shopping in recent years. These current problems can be addressed by trying new and innovative solutions to transform human behavior through design.

To pave the way for successful integration of affect in design, one research direction is the need to identify the right emotion to elicit in a certain context. For example, fear appeals discourage self-beneficial behavior such as smoking [75] and unsafe sex practices [76]. Fun and surprise can also be designed in the environment to make people throw waste or exercise. Guilt appeals, on the other hand, target pro-social behaviors such as making donations [77–79] and protecting the environment [80]. Hence, it may be more useful in the context of waste segregation. Thus, an emotion typology can be developed for human-environment interaction that can be used for research and design activities much like the one developed by Desmet [81] for human-product interaction.

In terms of domain, there is still limited research on the use of AD in health promotion, sustainable consumption, and artificial intelligence. The environment in vaccination sites can be made more calming or comforting to ease people's anxiety in healthcare environments. Young and inexperienced healthcare professionals in Canada, for instance, experienced high levels of anxiety at the beginning of the pandemic [82]. One of the few applications of AD in the healthcare environment investigated the desired affective qualities of primary health care environments [83]. Design attributes considered were play areas, lighting, sound level, colors, and the presence of green plants. Findings showed people's preference for calm feelings probably because disease cause anxiety in the first place. In a similar study, Dinis, Duarte [84] found that home elements evoked a positive emotional response in the hospital room. Most people have an aversion for hospitals because the hospital is a symbol of human vulnerability. Thus, designers can deliberately prevent these untoward feelings

by identifying environmental attributes that can alter moods and feelings to benefit patients and healthcare workers.

There is a dearth of literature to promote sustainable consumption, such as using less energy, minimizing carbon footprint, or just taking care of the environment using AD. The world's consumption culture is driving the planet to the edge. EDD is a provocative concept, but only a few case studies have been done to identify attributes that cause emotional durability. The relationship between actual product durability and emotional durability can also be examined, which should go hand in hand to realize reduced consumption benefits. A case in point is the mobile phone that fosters attachment to its owner only to be broken off by short battery life or technology upgrade. Is it possible to identify product life expectations for emotionally durable products as a guide for manufacturers?

An emerging topic of interest is artificial intelligence (AI), as it causes concern even to well-known technologists [85]. Associated anxieties are related to privacy violation, bias behavior, job replacement, learning, and ethics violation, to name a few [86]. Future research can dwell on designing sociotechnical systems that promote positive affective responses and diminish worry or panic. The sociotechnical theory aims to jointly optimize performance brought about by social and technical factors [87]. In the case of AI, however, the prevailing negative public perception impairs the integration of its beneficial application to society. Literature on the design of sociotechnical systems identified trust as a basis for interaction decisions [88]. Willingness to interact with technical systems is influenced by conformance to personal standards of trust and signals of trustworthiness. Sethumadhavan [89] identified relevant design factors that affect trust perceptions, such as appearance, ease of use, communication style, and transparency of the AI.

6. Conclusion

The integration of affect in design is a strategy that can be used to prompt behavior beneficial to society and the environment. Literature on AD suggests that a deliberate effort to manipulate design factors can work to elicit strong affective responses. AD literature is replete with applications in product and service design to increase consumption. More recent applications, albeit limited, showed that it could also

be auspiciously used to decrease consumption, minimize waste, and control infection. Future research can tackle the development of an emotion typology for human-environment interaction and solutions to modern-day problems of health promotion, sustainable consumption, and distrust of technologies.

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Conflict of interest

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References

- [1] Volkswagen. The Fun Theory 2 – an initiative of Volkswagen: The World's Deepest Bin. 2009. pp. <https://www.youtube.com/watch?v=qRgWttqFKu8>
- [2] Volkswagen. The Fun Theory 1 – Piano Staircase Initiative | Volkswagen. 2009. pp. <https://www.youtube.com/watch?v=SBymar3bds>
- [3] Norman D. Emotional Design: Why We Love (or Hate) Everyday Things. New York: Basic Books; 2003.
- [4] Aboulafia A, Bannon LJ. Understanding affect in design: an outline conceptual framework. *Theoretical Issues in Ergonomic Science*. 2004;5(1):4-15.
- [5] Erol A, Leblebici Basar D. Analysis of the turkish tulip-shaped tea glass's emotional design features using kansei engineering methodology. *A/Z ITU Journal of the Faculty of Architecture*. 2021;18(2):491-503.
- [6] Aguilar ADO, Bascos NMV, Lucena AB, Seva RR, editors. Designing Eco Bags for Product Attachment. *Convergence of Ergonomics and Design*; 2021 2021//; Cham: Springer International Publishing.
- [7] Mokhtarmanesh S, Ghomeishi M. Participatory design for a sustainable environment: Integrating school design using students' preferences. *Sustainable Cities and Society*. 2019;51.

- [8] Wang CH, Chin HT. Integrating affective features with engineering features to seek the optimal product varieties with respect to the niche segments. *Advanced Engineering Informatics*. 2017;33:350-9.
- [9] Bhandari U, Neben T, Chang K, Chua WY. Effects of interface design factors on affective responses and quality evaluations in mobile applications. *Comput Human Behav*. 2017;72:525-34.
- [10] Wijnands F, Gill T. 'You're not perfect, but you're still my favourite.' Brand affective congruence as a new determinant of self-brand congruence. *Journal of Marketing Management*. 2020;36(11-12):1076-103.
- [11] Hancock P, Pepe A, Murphy L. Hedonomics: The Power of Positive and Pleasurable Ergonomics. *Ergonomics in Design: The Quarterly of Human Factors Applications*. 2005;13:8-14.
- [12] Jordan PW. *Designing pleasurable products: an introduction to the new human factors*. London: Taylor and Francis; 2002.
- [13] Mugge R, Schoormans JPL, Schifferstein HNJ. 17 - product attachment: design strategies to stimulate the emotional bonding to products. In: Schifferstein HNJ, Hekkert P, editors. *Product Experience*. San Diego: Elsevier; 2008. pp. 425-40.
- [14] Seva RR, Duh HB-L, Helander M. *Structural Analysis of Affect in the Pre-purchase Context*. Singapore: Center for Human Factors and Ergonomics; 2006.
- [15] Richins ML. Measuring emotions in the consumption experience. *Journal of Consumer Research*. 1997;24:127-46.
- [16] Givechi R, Velasquez V. Positive space. In: McDonagh D, Hekkert P, Van Erp J, Gyi D, editors. *Design and Emotion: The experience of everyday things*. London: Taylor and Francis; 2004. pp. 43-7.
- [17] Desmet PMA. A multilayered model of product emotions. *The Design Journal*. 2003;6:4-13.
- [18] Nagamachi M. Kansei engineering as a powerful consumer-oriented technology for product development. *Appl Ergon*. 2002;33:289-94.
- [19] Matsubara Y, Nagamachi M. Hybrid Kansei engineering system and design support. *International Journal of Industrial Ergonomics*. 1997;19:81-92.
- [20] Nagamachi M. Kansei Engineering: a new ergonomic consumer-oriented technology for product development. *Int J Ind Ergon*. 1995;15:3-11.
- [21] Gan Y, Ji Y, Jiang S, Liu X, Feng Z, Li Y, et al. Integrating aesthetic and emotional preferences in social robot design: An affective design approach with Kansei Engineering and Deep Convolutional Generative Adversarial Network. *Int J Ind Ergon*. 2021;83.
- [22] Yan HB, Li M. An uncertain Kansei Engineering methodology for behavioral service design. *IISE Transactions*. 2021;53(5):497-522.
- [23] Ushada M, Wijayanto T, Trapsilawati F, Okayama T. Modeling SMEs' trust in the implementation of industry 4.0 using kansei engineering and artificial neural network: Food and beverage SMEs context. *Journal of Engineering and Technological Sciences*. 2021;53(2).
- [24] Helander M, Peng H, Khalid H. Citarasa engineering model for affective design of vehicles 2008. pp. 1282-6.
- [25] Helander M, Khalid H, Lim TY, Peng H, Yang XJ. Emotional needs of car buyers and emotional intent of car designers. *Theoretical Issues in Ergonomics Science*. 2012;2012.
- [26] Jiang H, Kwong CK, Liu Y, Ip WH. A methodology of integrating affective design with defining engineering specifications for product design. *International Journal of Production Research*. 2015;53.
- [27] Zhuang J-R, Guan Y-J, Nagayoshi H, Yuge L, Lee H-H, Tanaka E, editors. *Two-Dimensional Emotion Evaluation with Multiple Physiological Signals*. *Advances in Affective and Pleasurable Design; 2019 2019//*; Cham: Springer International Publishing.
- [28] Wang S, Yuan H, editors. *Deeper User Experience - Emotional Design*. *Advances in Affective and Pleasurable Design; 2019 2019//*; Cham: Springer International Publishing.
- [29] Zhang S, Zhang M, Yu X, Ren H. What keeps Chinese from recycling: Accessibility of recycling facilities and the behavior. *Resources, Conservation and Recycling*. 2016;109:176-86.
- [30] Flynn R, Bellaby P, Ricci M. The 'Value-Action Gap' in Public Attitudes towards Sustainable Energy: The Case of Hydrogen Energy. *The Sociological Review*. 2009;57(2_suppl):159-80.
- [31] McKenzie-Mohr D. Promoting sustainable behavior: An introduction to community-based social marketing. *Journal of Social Issues*. 2000;56:543-54.
- [32] Zhang B, Lai KH, Wang B, Wang Z. From intention to action: How do personal attitudes, facilities accessibility, and government stimulus matter for household waste sorting? *J Environ Manage*. 2019;233:447-58.
- [33] Tomas N, Nordmo V, Wei W, Liem A. A Sustainability and User-Centered Approach Towards Extending the Life-Cycle of Mobile Computers. *Advances in Intelligent Systems and Computing*. 2019; 825:822-30.
- [34] Environmental Protection Agency. *Facts and Figures about Materials, Waste and Recycling 2018* [Available from: <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials#recycling>]
- [35] Waite S, Cox P, Tudor T. Strategies for local authorities to achieve the EU 2020 50% recycling, reuse and composting target: A case study of England. *Resources, Conservation and Recycling*. 2015;105:18-28.
- [36] Tam V, Le K, Wang J, Illankoon IMCS. Practitioners Recycling Attitude and Behaviour in the Australian Construction Industry. *Sustainability*. 2018;10:1212.
- [37] Parker L. Here's how much plastic trash is littering the earth. *National Geographic* [Internet]. 2018 [cited 2021 August 22, 2021]. Available from: <https://www.nationalgeographic.com/science/article/plastic-produced-recycling-was-te-ocean-trash-debris-environment>
- [38] Chapman J. *Emotionally Durable Design: Objects, Experiences and Empathy*. Oxfordshire, England: Routledge; 2015.
- [39] Haines-Gadd M, Chapman J, Lloyd P, Mason J, Aliakseyeu D. Emotional Durability Design Nine-A Tool for Product Longevity. *Sustainability*. 2018;10.
- [40] Bulow J. An Economic Theory of Planned Obsolescence. *The Quarterly Journal of Economics*. 1986;101(4):729-50.
- [41] Schifferstein R, Zwartkruis-Pelgrim E. Consumer-Product Attachment: Measurement and Design Implications. *International Journal of Design*. 2008;2.
- [42] Vanhamme J, Snelders D. What if you surprise your customers... Will they be more satisfied? Findings from a pilot experiment. *Advances in consumer research Association for Consumer Research (US)*. 2003;30:48-55.

- [43] Wallendorf M, Arnould E. "My Favorite Things": A Cross-Cultural Inquiry into Object Attachment, Possessiveness, and Social Linkage. *Journal of Consumer Research - J CONSUM RES.* 1988;14.
- [44] Krieken BMV, Desmet P, Aliakseyeu D, Mason J, editors. *A Sneaky Kettle - Emotionally Durable Design Explored in Practice* 2011.
- [45] Agost M-J, Vergara M. Principles of Affective Design in Consumers' Response to Sustainability Design Strategies. *Sustainability.* 2020;12.
- [46] Singh G. *Fast Fashion Has Changed the Industry and the Economy: Foundation for Economic Education*; 2017 [Available from: <https://fee.org/articles/fast-fashion-has-changed-the-industry-and-the-economy/>]
- [47] Muthu SS, Li Y, Hu JY, Mok PY, Ding X. Eco-Impact of Plastic and Paper Shopping Bags. *Journal of Engineered Fibers and Fabrics.* 2012;7(1):155892501200700103.
- [48] Balasbas JCB, Co LJO, Verra SMS. *A Study on the Influence of the Affective Design of Shopping Paper Bags on the Consumer's Recycling Decision* Manila: De La Salle University; 2019.
- [49] Karmarkar UR, Bollinger B. BYOB: How Bringing Your Own Shopping Bags Leads to Treating Yourself and the Environment. *Journal of Marketing.* 2015;79(4):1-15.
- [50] Moon KK-I. *Purchase Intention of Korean Consumers toward Eco-bag.* Korea: Seoul National University; 2015.
- [51] WRAP. *Plastic carrier bag consumer research.* UK: WRAP; 2020.
- [52] Vergara SE, Tchobanoglous G. *Municipal Solid Waste and the Environment: A Global Perspective.* *Annual Review of Environment and Resources.* 2012;37(1):277-309.
- [53] Yukalang N, Clarke B, Ross K. Barriers to Effective Municipal Solid Waste Management in a Rapidly Urbanizing Area in Thailand. *Int J Environ Res Public Health.* 2017;14(9).
- [54] Austin J, Hatfield D, Grindle A, Bailey J. Increasing recycling in office environments: The effects of specific, informative cues. *Journal of Applied Behavior Analysis.* 1993;26:247-53.
- [55] Wu DWL, Lenkic PJ, DiGiacomo A, Cech P, Zhao J, Kingstone A. How does the design of waste disposal signage influence waste disposal behavior? *Journal of Environmental Psychology.* 2018;58:77-85.
- [56] Verdonk S, Chiveralls K, Dawson D. *Getting Wasted at WOMADelaide: The Effect of Signage on Waste Disposal.* *Sustainability.* 2017;9:344.
- [57] Mallett RK. Eco-Guilt Motivates Eco-Friendly Behavior. *Ecopsychology.* 2012;4(3):223-31.
- [58] Dy AK, Lazo M, Santos AG, Seva R, editors. *Affective Trash Bin Signage to Promote Waste Segregation.* *Proceedings of the 21st Congress of the International Ergonomics Association (IEA 2021); 2021 2022//; Cham: Springer International Publishing.*
- [59] Champion VL, Skinner CS. *The health belief model. Health behavior and health education: Theory, research, and practice,* 4th ed. San Francisco, CA, US: Jossey-Bass; 2008. pp. 45-65.
- [60] Zitek EM, Schlund RJ. Psychological entitlement predicts noncompliance with the health guidelines of the COVID-19 pandemic. *Pers Individ Dif.* 2021;171:110491.
- [61] Aschwanden D, Strickhouser JE, Sesker AA, Lee JH, Luchetti M, Stephan Y, et al. Psychological and Behavioural Responses to Coronavirus Disease 2019: The Role of Personality. *European Journal of Personality.* 2020;n/a(n/a).
- [62] Occupational Safety and Health Administration. *Guidance on preparing workplaces for an influenza pandemic.* Washington, DC: US Department of Labor; 2009.
- [63] Wong SC, AuYeung CHY, Lam GKM, Leung EYL, Chan VWM, Yuen KY, et al. Is it possible to achieve 100 percent hand hygiene compliance during the coronavirus disease 2019 (COVID-19) pandemic? *J Hosp Infect.* 2020;105(4):779-81.
- [64] Zivich PN, Huang W, Walsh A, Dutta P, Eisenberg M, Aiello AE. Measuring office workplace interactions and hand hygiene behaviors through electronic sensors: A feasibility study. *PLoS One.* 2021;16(1):e0243358.
- [65] Zimmerman P-A, Sladdin I, Shaban R, Gilbert J, Brown L. Factors influencing hand hygiene practice of nursing students: A descriptive, mixed-methods study. *Nurse Educ Pract.* 2020;44:102746.
- [66] Lotfollahzadeh A, Rastgoo L, Shirinzadeh I, Kharghani Moghadam SM, Ebrahimi H. Investigating the compliance of COVID-19 protocols in the workplaces of Ardabil, Iran. *Work.* 2021;70:1031-7.
- [67] Hasanica N, Catak A, Mujezinovic A, Begagic S, Galijašević K, Oruč M. The Effectiveness of Leaflets and Posters as a Health Education Method. *Materia Socio Medica.* 2020;32:135.
- [68] Caris M, Labuschagne HA, Dekker M, Kramer MHH, Agtmael M, Vandenbroucke-Grauls C. Nudging to Improve Hand Hygiene. *J Hosp Infect.* 2017;98.
- [69] Lunn PD, Timmons S, Belton CA, Barjaková M, Julienne H, Lavin C. Motivating social distancing during the COVID-19 pandemic: An online experiment. *Soc Sci Med.* 2020;265:113478.
- [70] Lawson A, Vaganay Miller M. The Effectiveness of a Poster Intervention on Hand Hygiene Practice and Compliance When Using Public Restrooms in a University Setting. *Int J Environ Res Public Health.* 2019;16.
- [71] Lerner JS, Keltner D. Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition and Emotion.* 2000;14(4):473-93.
- [72] Van Cappellen P, Rice EL, Catalano LI, Fredrickson BL. Positive affective processes underlie positive health behaviour change. *Psychol Health.* 2018;33(1):77-97.
- [73] Carpenter SM, Niedenthal PM. Emotional processes in risky and multiattribute health decisions. *Psychol Health.* 2018;33(1):58-76.
- [74] United Nations. *The Sustainable Development Goals Report 2020.* 2021.
- [75] Manyiwa S, Brennan R. Fear appeals in anti-smoking advertising: How important is self-efficacy? *Journal of Marketing Management.* 2012;28(11-12):1419-37.
- [76] Honnen TJ, Kleinke CL. Prompting bar patrons with signs to take free condoms. *J Appl Behav Anal.* 1990;23(2): 215-7.
- [77] de Luca R, Ferreira M, Botelho D. *When Guilt Induces Charity: The Emotional Side of Philanthropy* 2015.
- [78] Lwin M, Phau I. Effective advertising appeals for websites of small boutique hotels. *Journal of Research in Interactive Marketing.* 2013;7(1):18-32.
- [79] Hibbert S, Smith A, Davies A, Ireland F. Guilt appeals: Persuasion knowledge and charitable giving. *Psychology & Marketing.* 2007;24(8):723-42.
- [80] Jiménez M, Yang KCC. How Guilt Level Affects Green Advertising Effectiveness? *Journal of Creative Communications.* 2008;3(3):231-54.

- [81] Desmet PMA. Faces of Product Pleasure: 25 Positive Emotions in Human-Product Interactions. *International Journal of Design*. 2012;6:1-29.
- [82] Cléophat JE, Simon P, Chiniara G, St-Pierre L, Ahossi E, Dogba MJ, et al. How anxious were Quebec healthcare professionals during the first wave of the COVID-19 pandemic? A web-based cross-sectional survey. *Work*. 2021;70:701-12.
- [83] Ayas E, Eklund J, Ishihara S. Affective design of waiting areas in primary healthcare. *The TQM Journal*. 2008;20(4):389-408.
- [84] Dinis S, Duarte E, Noriega P, Teixeira L, Vilar E, Rebelo F, editors. *Evaluating Emotional Responses to the Interior Design of a Hospital Room: A Study Using Virtual Reality. Design, User Experience, and Usability User Experience in Novel Technological Environments*; 2013 2013//; Berlin, Heidelberg: Springer Berlin Heidelberg.
- [85] Johnson DG, Verdicchio M. AI Anxiety. *Journal of the Association for Information Science and Technology*. 2017;68(9):2267-70.
- [86] Li J, Huang J-S. Dimensions of artificial intelligence anxiety based on the integrated fear acquisition theory. *Technology in Society*. 2020;63:101410.
- [87] Walker GH, Stanton NA, Salmon PM, Jenkins DP. A review of sociotechnical systems theory: a classic concept for new command and control paradigms. *Theoretical Issues in Ergonomics Science*. 2008;9(6):479-99.
- [88] Jones AJI, Artikis A, Pitt J. The design of intelligent socio-technical systems. *Artificial Intelligence Review*. 2013;39(1):5-20.
- [89] Sethumadhavan A. Trust in Artificial Intelligence. *Ergonomics in Design*. 2018;27(2):34-34.