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Probing Cultural Differences in Product Design and Consumer Evaluation Using Repertory Grid Analysis

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Abstract

Culture plays an essential role in the success of product design, especially in the age of a global economy where there is a high probability of discrepancy between the designer's intention and the consumer's response. However, the role of culture is often challenging to identify and measure. In the current paper, we employed Repertory Grids (RG) to investigate differences in UK and Chinese participants' evaluations of designs, which were themselves from both UK and Chinese students. The techniques of Honey's Content Analysis (HCA) and Principal Components Analysis (PCA) were applied to integrate the analysis of both the collected qualitative and quantitative data. The results show that the two groups tended to focus on a similar range of design aspects (i.e. aesthetics, form/shape, usability, creativity, and functionality), but apply different criteria in evaluating such aspects.The UK and Chinese designs were found to be distinctive from each other and tended to appeal more to the people from the same cultural background. The findings reveal the interplay between culture and design and underline the importance of integrating culture into design education.

Keywords - product design; consumer evaluation; culture; repertory grid; cross-cultural comparison

Introduction

As Mugge et al. (2018) claimed, design can be conceptualised as a communication process, which allows a high probability of discrepancy between the designer's intention and the consumer's response. Particularly in globalization, the probability of such discrepancy is increasing due to the growing diversity of cultures in which the designers are educated, and to which the products are introduced (Wodehouse and Maclachlan 2014). The influence of culture on people's daily life can be explicit, for example it influences our daily eating, dressing, and consumption habits (e.g. Lake, Staiger, and Glowinski 2000; Hansen 2004; Passini 2013). It also affects more recessive domains such as our cognitive patterns of communicating, understanding, and perceiving (e.g., Chiu 1972; Markus and Kitayama 1991; Nisbett et al. 2001). In the communication between the designer and the intended user of a product, culture must be considered when establishing a framework of information exchange (Razzaghi et al. 2009). As a result of their intrinsic cultural values and preferences, designers tended to manifest culture in their design consciously or unconsciously (Razzaghi et al., 2009). Cultural values also provide designers with a rich and varied set of material to inspire their design concepts (Gaver et al. 1999; Van Boeijen et al. 2017). However, culture is also essential in determining the ways consumers interpret and associate with certain aspects of a product (Creusen 2004). Scholars have proposed that people from different cultures tend to evaluate products differently (e.g., Seva and Helander 2009; Moon, Miller, and Kim 2013), leading Van Boeijen et al. (2017, p. 2) to claim that cultural awareness "may be key to the success of the interaction between designers and the intended users" (Van Boeijen et al. 2017, p. 2). A necessary step to achieve such success is to ascertain culture's role from both the designer's and the consumer's perspectives.

The UK and China were the cultural representatives being compared in this research. These are typical examples of Western and Eastern Asian cultures, respectively. According to Hofstede et al.'s (2010) cultural dimensions and the corresponding indexes, the UK and China are distinctive in many aspects. First, the UK is a society with small power distance while China is a typical large-power-distance society. Thus, compared to their UK counterparts, Chinese people have much more tolerance of the inequality of power distribution. Second, the UK is a typical individualistic society, whereas China is a typical collectivism society. Thus, Chinese people tend to value collective interests much more than UK people, and consider this as a more important part of their identity. Third, the UK is an indulgent society with people valuing positive attitudes and leisure. In contrast, China is a typical restrained society with fewer very happy people and lower importance given to leisure. Fourth, the UK society is typically short-term orientated, valuing freedom, rights, achievement, and thinking for oneself; whereas China, on the other hand, is a typical long-term orientated society and values learning, honesty, adaptiveness, accountability, and self-discipline. Thus, the dominant cultural differences between the UK and China make them an ideal sample for cross-cultural design research.

Based on the above, an empirical study was designed to compare student designers' design work among the UK and Chinese participants. It aimed to reveal the role of culture at two levels: 1. from the consumer's perspective, to identify if there are differences in design evaluation between the UK and Chinese participants and specify the corresponding discrepancies; 2. from the designer's perspective, to explore if there are differences in designs from the UK and Chinese student designers and specify the corresponding discrepancies.

The contributions of the current paper to the design and education literature are twofold. First, the majority of cross-cultural design research focuses on the domain of website design. By creatively applying the repertory grids (RG) technique, the current paper empirically reveals product designers' unconscious integration of culture in design and the influence of such cultural manifestation on design evaluation. Second, concerning the homogenization and lack of diversity in current design education, it empirically confirms the necessity of integrating culture in design education and identifies ways in which this might be achieved.

Theoretical Background

The Concept of Culture

Hofstede et al. (2010) described culture as the "software of the mind" and defined it as "the collective programming of the mind that distinguishes the members of one group or category of people from others" (p.6). The immeasurable quality of the "mind" leaves the measurement of culture a perennial problem, resulting in difficulty in ascertaining the relationship between culture and design. Some implications of such a relationship may be found in the definitions of culture. Kroeber and Kluckhohn (1952, p. 181) describe culture as something that "consists of pattern, explicit and implicit, of and for, behaviour acquired and transmitted by symbols, constituting the distinctive achievement of human groups, including their embodiments in artefacts". Design, i.e. the "artefacts" in the definition, is interpreted as a carrier of culture. Such an interpretation was further illustrated by the "onion" model of culture from Hofstede

(2010, p. 8), which divides the concept of culture into four layers, i.e. symbols, heroes, rituals, and values. The symbols are "words, gestures, pictures, or objects that carry a particular meaning", in which designs are included. These definitions imply a symbiotic relationship between culture and design: first, products or artefacts, which are the outcome of a design process, are the medium through which culture is manifested and embodied (Brett et al. 1997). Also, culture provides the context in which designs are created. It has pervading effects on designs and can therefore be regarded as fundamental in understanding designs (Crilly et al. 2004; Razzaghi and Ramirez 2009).

Cultural Manifestations in Design and its Effects on Consumers

The influence of culture on design can be observed when designers encode in their designs a meaning derived from a particular culture (McCracken 1986). Razzaghi et al. (2009) contend that culture is integrated into design via two pathways, i.e. 'consciously', where cultural preferences and needs of users are deliberately considered by the designer and included in the the solutions; and 'unconsciously', where the designer's cultural concerns and preferences "reflexively and unintentionally emerge" in the design solutions (p. 440). The current paper focuses on the latter pathway. Indeed, the necessity of integrating culture into design has been increasingly recognized in the academic literature. For example, in the domain of website design, the role of culture has been studied from many perspectives, e.g. the manifestation of cultural values in websites, the investigation of cultural markers in websites, and the influence of culture on user's perceptions of online stimuli (e.g., Herrando, Jiménez-Martínez, & Martín-De Hoyos, 2019; Moura et al., 2016; Snelders et al., 2011). The related findings suggest that users tend to appreciate design styles that express specific values, and shared values between designers and users are a direct precursor that leads to higher acceptance of and trust on designs (e.g. Herrando, Jiménez-Martínez, & Martín-De Hoyos, 2019; Moura et al., 2016; Snelders et al., 2011).

In terms of product design, there are also many studies discussing cultural aspects of design, generally from the perspective of design outcomes and design processes. For example, Razzaghi et al.'s (2009) research compared the cultural differences in product design ideas between Australian and Iranian design students. They suggested that the embodiment of cultural content could enhance a product's appeal and deepen and further enrich the corresponding experience of the intended users. Lotz and Sharp's (2017) protocol studies identified variations in sketched-based ideation process between UK and Botswanan designers owing to the influence of cognitive style and cultural background. He and Wang (2017) found that global brands' cultural compatibility has a direct positive effect on purchase likelihood.

Nevertheless, compared to the research on website design, there is still limited cross-cultural research to specify the differences in cultural manifestation in designs from designers with different cultural backgrounds and examine the effects of such cultural adaptation on user evaluation (Razzaghi et al. 2009). The question remains unanswered how designs from different cultures differ from each other and how people from different cultures identify and value with their own culture. The current paper aims to address this question.

Culture and Design Education

Culture is learned, rather than being inherent to people (Ashton and Deng 2010; Hoyos et al. 2015), and this provides the premise of integrating culture into design education. There is empirical evidence of the benefits of intercultural or cross-cultural learning in design education. For instance, Hoyos et al. (2015) found that their short term design study tour brought the benefits of international exchange and cultural immersion, experiences which will enhance students' cross-cultural awareness and help them build a better understanding of different people and prepare them for working in the interconnected global world. In related research, Scharoun, Peng, & Turner (2016) also demonstrated that such cross-cultural experiences could help enhance students' Cultural Intelligence (i.e., an individual's ability to function in various cultural contexts (Wood and St. Peters 2014)) and cultivate work-ready graduates. Hsieh et al. (2017) organised a Papora aboriginal community art project with design students. They found that participation in such an intercultural project helped the students identify with and value their own culture and allowed them to gain the ability to transfer abstract culture into a practical design to generate creative outcomes.

However, intercultural or cross-cultural design projects are still rare. There are potential challenges in applying such projects. For instance, it has to secure a specific type of funding support (e.g. Hoyos et al. 2015). Its multicultural nature requires educators to cultivate awareness and sensitivity to cultural differences and develop skills for culturally sensitive and culturally adaptive teaching and learning (Parrish and Linder-vanberschot 2010). Meanwhile, globalization has led to homogenization and lack of diversity in designs and design education (Norman 2012), regardless of the diverse cultural backgrounds of the designers and the target consumers. The reality remains that most product design courses still suffer from a lack of subjects related to the links between design and culture, and culture is still "a neglected concept" (Razzaghi and Ramirez 2009, p. 483). By examining the role of culture in design, the current research aimed to empirically prove the necessity of integrating culture in design education and explore potential ways to achieve such integration.

Measuring Cultural Differences in Design and Design Evaluation

Culture in the context of the design domain has been studied through cultural constructs proposed by different scholars such as the dimensions from Hofstede (2010) , Schwartz's (1992) seven cultural values, and Trompenaars and Hampden-Turner's (2012) seven cultural dimensions. Cultural constructs are frequently used to predict attitudes towards external stimuli or behaviours and data is commonly gathered using research methods such as questionnaires or interviews (Tomico et al., 2009). However, as Hofstede (2006) suggested, such cultural dimensions are generally at a high level of abstraction and far above the respondents' daily concerns. When it comes to a detailed analysis of design attributes and the corresponding evaluation, it is reasonable to suspect the applicability of such cultural constructs in measuring cultural differences and the fruitfulness and meaningfulness of any results. The repertory grids (RG) method was adopted and adapted in the current paper to address the research questions to investigate the role of culture in design at an individual level.

RG was a technique developed by psychologist George Kelly (1955) to help his clients analyse their interpersonal relationships. It is based on his explicit theory of human understanding known as the Personal Construct Theory, with a central assumption that people construct their world by using a finite number of dichotomous constructs rather than absolutes. The aim of developing this method was "to get beyond the words" – it promises accurate measurements of subtle perceptions (Easterby-Smith 1980).

Jankowicz (2003, p. xviii) contended that RG was still a technique "little used beyond its specialist adherents". Though still low in quantity, RG has been increasingly used in different areas in recent years. One of such areas is the design domain. As Kuru (2016) claimed, the applicability of RG in qualitative and quantitative data collection makes it utilisable at different stages of a design process. When requirement elicitation is the first and most crucial activity at an early design stage, RG can be adopted to understand initial user needs and requirements through comparison of design ideas (e.g., Kuru 2016, Süner & Erbuğ, 2016). At the evaluation stage, it can be applied to analyse the specific criteria people use to evaluate a design (e.g. Fallman & Waterworth, 2005; Tomico et al., 2009) and the particular ways people perceive the design (e.g. Fu et al. 2016).

The hybrid qualitative-quantitative nature of RG allows for qualitative and quantitative analysis (Höft et al. 2019; Kuru 2016; Tomico et al. 2009). Qualitative analysis in RG is done through content analysis of the constructs. It works by revealing the patterns of constructs within "highly subjective and individual data"(Fallman and Waterworth 2010, p. 258). For example, Tomico et al. (2009) used the number of constructs, the elicitation order, and the range of constructs in each category to determine the dominance, importance, and descriptiveness and understand how people perceive and differentiate between products. However, as Fallman and Waterworth (2005) pointed out, such analysis is 'statistically blind', as it sacrifices the rich statistical information carried in the grids' numerical ratings. Quantitative analysis, on the other hand, used the ratings as the basis for applying statistical analyses to search for potential patterns in the information carried by the numerical data. It works well in revealing hidden correlations between constructs. However, it is still 'semantically blind', as it sacrifices the constructs' semantical contents. Therefore, scholars have tried to bring the two types of analysis together. For example, Kuru (2016) used cross impact analysis to reveal the essential constructs as it shows both the numerical relation between constructs as well as the semantic contents. As a cross-cultural study in design, the current paper proposes a new method to analyse both the qualitative and quantitative information when people evaluate designs to reveal the corresponding influence of culture.

Research Method

Study Set-up

Design work was collected from students in the undergraduate program of Product Design and Manufacturing from both the UK and China campuses of the University of Nottingham. The students were educated using the same teaching materials and study system, which made their design work suitable for cross-cultural comparison, including modules in design-related skills (e.g. sketching, design software) and knowledge (e.g. material and manufacturing, ergonomics). No module related to the topic of culture was covered. English was the official language for teaching and learning in both campuses. were Each side's teaching team consisted of two groups of people, i.e. teachers from the university and design practitioners from local industries. The three primary teachers from the UK side were all British, one with a Bachelor's degree and two with PhD degrees in design-related disciplines. The two design practitioners were also British. There were two Chinese teachers with PhD degrees and one British teacher with a

Bachelor's degree on the China side. The two design practitioners were both Chinese from local industries.

Nine pieces of the design work were collected from nine students in the equivalent year from each campus, to be used as the comparison material in this study (see Figures 1 and 2). The work related to a design task to design a stationery rack for students aged 14 to 18 years old. The design brief also mandated that the product be manufactured by injection moulding, and that there must be space on the product for a company logo. The students were allowed four weeks to finish the design task, and during this period they could discuss their design ideas and the corresponding progress with their teachers in each week's class. The teachers would give comments or suggestions from different perspectives, such as manufacturing, ergonomics, etc. This was the first design task they were assigned in their undergraduate program; correspondingly, the sketching and design skills were not sophisticated. However, this spontaneity in the design process made it a good choice for cross-cultural comparison.

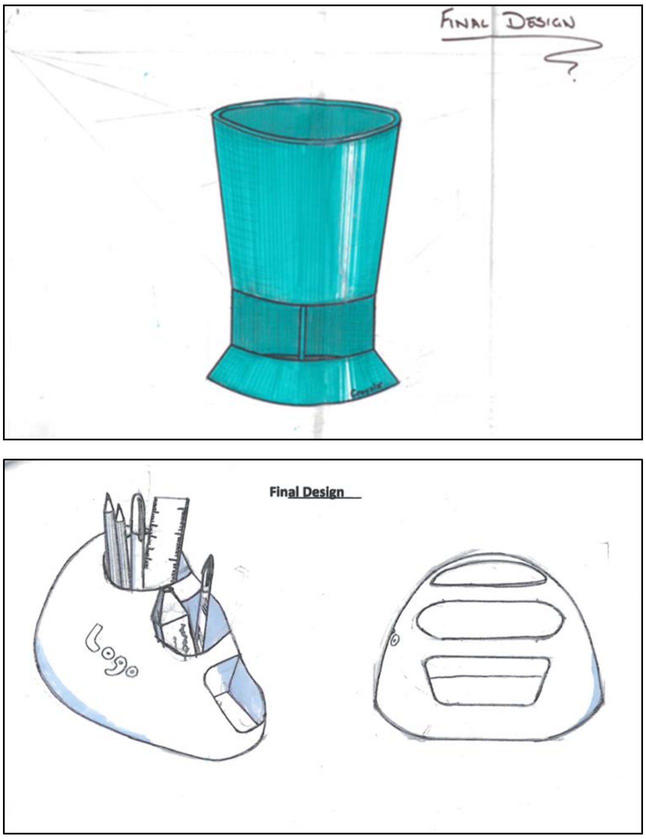

Figure 1 Examples of UK students' designs

Another twenty participants were recruited via advertisements sent to social media to evaluate the students' designs, comprised of two equal groups, i.e. the UK group and the Chinese group, with five male and five female in each group. The mean age of the UK male group was 35.0 years (SD = 5.8 years), and female 46.6 years (SD = 19.6 years). The Chinese male group's mean age was 32.4 years (SD = 4.3 years), and female 37.4 years (SD = 5.3 years).

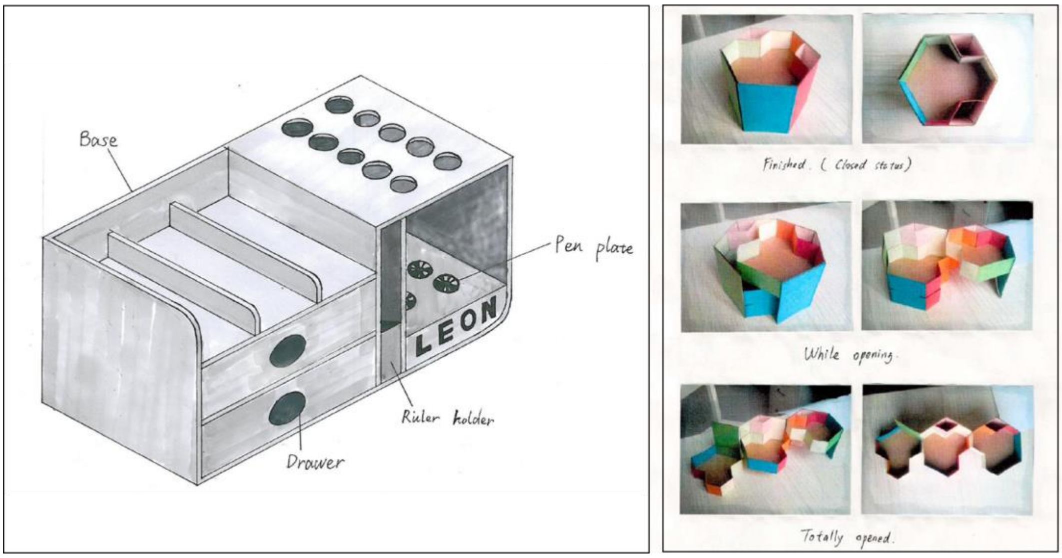

Figure 2 Examples of Chinese students' designs

Repertory Grids for Comparing Designs

There are three main components in a full RG. The first a **construct**, which is the description and interpretation about a specific topic, elicited from the participants. An **element** is another critical component, a sample chosen to represent the topic (Fransella 1977). The third component is a **rating**, which refers to how the participants interpret each element according to each construct. The elements were the 18 pieces of design work (nine from UK students and nine from Chinese students) in the current research. The constructs are the pairs of descriptions the participants used to describe the designs. The ratings were made in an evaluation of each design according to the constructs developed. Figure 3 shows an RG sheet from one of the participants of the current research. The numbers of "1" to "18" in the second row present the elements, i.e. the designs collected in this study. The numbers under each element are the participant's ratings of the 18 designs according to the constructs in the grids under the number "1" and "7".

Procedure

The number of elements was restricted to 18 to ensure a variety of the samples and make the interviews efficient and productive. The elements were randomly arranged in triads (i.e. make three designs as a group) with the following condition: in each triad, there were at least one UK design and one Chinese design. It was to ensure that each design would be evaluated at least once by each participant.

During the interview, the participants were shown a triad of designs (sketches or pictures of the final designs) each time. For every triad, they were asked: "Which two of these designs are alike in some way, and different from the third?" They were encouraged to give at least one similarity/difference for each triad. Laddering down and up procedures were applied to the constructs, i.e. the participants were encouraged to explain their constructs to obtain a clear and deeper understanding. It is a strong tool for eliciting in-depth, value-laden "superordinate" constructs (e.g., Süner and Erbuğ 2016). Also, they were asked to rate the designs according to the constructs using a seven-point scale. For example, when the participants were shown a triad of designs and came up with a construct of "simple shapes vs. complex shapes", they would first be asked to explain further what they meant about these words. Then, they would be asked to rate the triad of designs: "imagine the words 'simple shapes' define the '1' end of a 7-point scale, and the words' complex shapes' define the '7' end of a 7-point scale, please rate the three designs on this scale." They would also rate each of the remaining designs on this construct. The same procedure continued until no new descriptions occurred for two consecutive triads. They were then given an overall evaluating construct which assessed the extent to which they judged the designs as either "bad design" or "good design". The English participants' interviews were conducted in English, and the interviews with the Chinese participants were conducted in Chinese. The results of the Chinese participants were translated into English by the researchers.

Construct	**1**	**Element**																		**7**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	
1	simple shapes	3	2	2	1	2	3	3	3	3	7	4	3	3	4	4	5	6	6	complex shapes
2	curve lines	3	2	3	1	2	3	2	2	1	7	5	3	1	3	2	2	3	2	jagged lines
3	modern fashion	4	6	2	2	1	2	4	7	4	1	2	1	6	5	4	1	3	6	old fashion
4	storage options	4	5	7	6	3	5	3	3	3	1	2	5	4	1	2	5	2	2	low variety of storage options
5	easy to use	1	1	1	1	1	1	2	1	1	6	2	6	1	1	3	5	3	2	difficult to use
6	play on the desk	3	2	2	2	2	6	3	2	3	5	3	7	1	2	2	5	4	2	difficult to display on the desk
7	useful	3	2	1	1	1	2	2	1	2	6	3	6	2	1	3	5	3	2	not useful
8	looks good	3	4	4	2	2	3	5	3	3	6	5	4	3	2	3	3	4	2	ugly
9	high durability	1	1	1	1	1	2	3	1	2	5	4	3	3	2	4	4	2	2	low durability
10	**good design**	**1**	**2**	**3**	**1**	**1**	**2**	**3**	**2**	**2**	**5**	**3**	**3**	**2**	**2**	**3**	**4**	**3**	**2**	**bad design**

Figure 3. An RG sheet from the current research

Data Analysis and Results

In total 171 constructs were collected, with 94 constructs from the UK participants (mean = 9.4, SD = 2.95), and 77 from the Chinese participants (mean = 7.7, SD = 1.05). Different methods were applied to fully analyse the relationship between constructs and between elements to understand the information carried in the grids.

Information Carried in the Relationships between the Constructs

Content analysis was first conducted on all the constructs. It is a method in which all the constructs are brought together and classified based on their meanings (Jankowicz, 2003). A procedure of classification following the core-categorisation procedure introduced by Jankowicz (2003) was applied. It was conducted by one of the researchers and a reliability check collaborator who was with a design background but not from the research team. After about three rounds of reliability checks, a similarity percentage of 90.3% was achieved. The categorization results are presented in Table 1.

A total of six categories was identified from all the elicited constructs. The category of **aesthetics** covered the constructs commented directly on the aesthetical features such as the appearance, colour, texture, etc. There were constructs referring specifically to the **form or shape** of the design, and they were grouped as an individual category. The category of **usability** refers to the evaluation of the ease of access and use of the design, as well as its effectiveness and efficiency in use. **Creativity** here refers to the description of the novelty of functionality, design ideas, or appearance. **Functionality** refers to the quality or quantity of functions shown in the design. The category of **Miscellaneous** refers to the constructs that do not belong to any of the above categories.

Table 1 The number of constructs in each category

Category	Definition	UK	CN	Total
Aesthetics	Words/phrases relating to aesthetical features such as the overall appearance, colour, texture, etc.	16	14	30
Form/shape	Words/phrases about the features in the overall or detailed form/shape	29	23	52
Usability	Words/phrases relating to ease of access and use, effectiveness, and efficiency of the design	24	20	44
Creativity	Words/phrases About the creativity in form/functionality/design ideas, etc.	11	9	20
Functionality	Words/phrases relating to the functionality of the design	10	7	17
Miscellaneous	Constructs that cannot be categorised to any of the listed ones	4	4	8
Total		94	77	171

Note. "UK" stands for the UK participant group, and "CN" stands for the Chinese participant group. The same below.

A chi-square test was applied to explore the independence between the categories and the two groups. According to the result of the chi-square test, i.e. $X^2_{obs} = 0.23$. X^2_{crit} (df =5; $p < 0.05$) = 11.07 > X^2_{obs}, there is no relationship between the cultural background and the categorising preference.

The above results are obtained merely on the semantical contents of the constructs and without engaging the elements' ratings. The method of Honey's (1979, cited in Jankowicz 2003) content analysis (HCA) was applied here to make full use of the statistical information carried in the ratings. A key component in HCA is an overall construct. It is used to detect each construct's relationship and the participant's overall evaluation of the elements. In the current research, the overall construct is the overall evaluation good vs. bad design, elicited with the question: "As a general feeling: how would you rate each of them on a scale that goes from 'good design'=1 to 'bad design'=7?" HCA calculates the differences between each construct's ratings and the overall constructs and then converts the differences into percentage similarity scores to ensure comparability with other grids (1).

$$100 - \frac{SD}{(LR-1)\times E} \times 200 \quad (1)$$

Note. SD = sum of differences, LR = largest rating, E = the number of elements

Based on the similarity scores, each participant's constructs were grouped into the highest (H), intermediate (I) and lowest (L) third. The "H" constructs are the ones that are statistically close to the overall "good design vs bad design" constructs in terms of the ratings. They indicate the most important criteria the participants used when they judge the excellence of the designs. The numbers of "H" constructs are shown in Table 2.

Table 2 The number of "H" constructs in each category

Category	UK	CN	Total
Aesthetics	6	9	15
Form/shape	7	1	8
Usability	11	11	22
Creativity	5	4	9
Functionality	1	4	5
Miscellaneous	0	1	1
Total	30	30	60

A chi-square test was again applied to explore the independence between the categories and the two groups. The results show that $X^2_{obs} = 8.01$, which is smaller than X^2_{crit} (df =5; $p < 0.05$) = 11.07. It suggests that, by integrating the constructs' statistic and semantic meanings, no relationship between the cultural background and categorising preference was detected.

Information Carried in the Relationships between the Elements

This section explores the relationship between the elements. Applied to the current research, it reveals the differences in the designs according to the participants' evaluation. The method of Principal Component Analysis (PCA) was applied to the overall grids of UK participants (94 constructs) and Chinese participants (77 constructs), respectively.

PCA's core idea is to reduce the dimensionality of the data with a large number of interrelated variables while keeping as much existing variation as possible (Höft et al. 2019). The principal components are linear combinations of the variables. It is used by revealing a small number of components to explain a maximum variance in the data. In the case of RG, the variables are the constructs. The principal components are obtained by computing the ratings of the constructs based on the correlation matrix. The first principal component explains a maximum variance in the data. The second principal component explains a maximum of the remaining variance. The two components are uncorrelated and therefore, orthogonal to each other (Höft et al. 2019). For example, in the UK group's PCA graph in Figure 4, the horizontal axis stands for the first principal component (taking up 28.4% of the overall data) and vertical axis stands for the second principal component (taking up 17.1% of the overall data). The two components present the two most distinct patterns of variability that exist in the ratings of the constructs from the UK group. The other lines lying across the four quadrants represent the constructs, with the two sides representing the two poles of each construct. The angle between any two construct lines stands for the correlation between the constructs according to their ratings, i.e. the smaller the angle, the more similar the ratings. The angle between a construct line and the component line represents the correlation between the construct and the main component in the same way. The dots on the graph present the elements, namely the designs. Their positions on the graph demonstrate their correlation with the component lines, the constructs line, and each element (Jankowicz, 2003).

When applying PCA in a sophisticated construct system, the two components shown on a two-dimensional map would be illustrating less than the total picture (Easterby-Smith 1980; Höft et al. 2019). In the current research, PCA was used to analyse the patterns in ten participants' grids' data. In such a supergrid, the two components only represent a relatively small percentage of the total data (e.g. in the Chinese group's grids, with 23.3% of the first component and 19.4% of the second component, giving a total of 42.7%). Although the percentages taken by the two components are relevantly low, the results shown in the two PCA graphs are conspicuous. In the PCA graph of each group, the UK and Chinese designs tend to be plotted in a specific pattern: the UK designs tended to gather together in a particular area in the graph, and the same was the Chinese designs (See Figure 4 and 5). Take the UK group as an example: the Chinese designs gather in the first quadrant and part of the adjacent fourth quadrant (except for design CN7, see the dashed box in Figure 4); and the UK designs were scattered in the second, third, and the lower part of the fourth quadrant. Similar situations exist in the PCA graphs of the Chinese group: the Chinese designs gathered mainly in the fourth quadrant and part of the adjacent third quadrant (except for design CN7, see the dashed box in Figure 5); and the UK designs mainly located in the first, second, and the upper part of the third quadrant (except for design UK2).

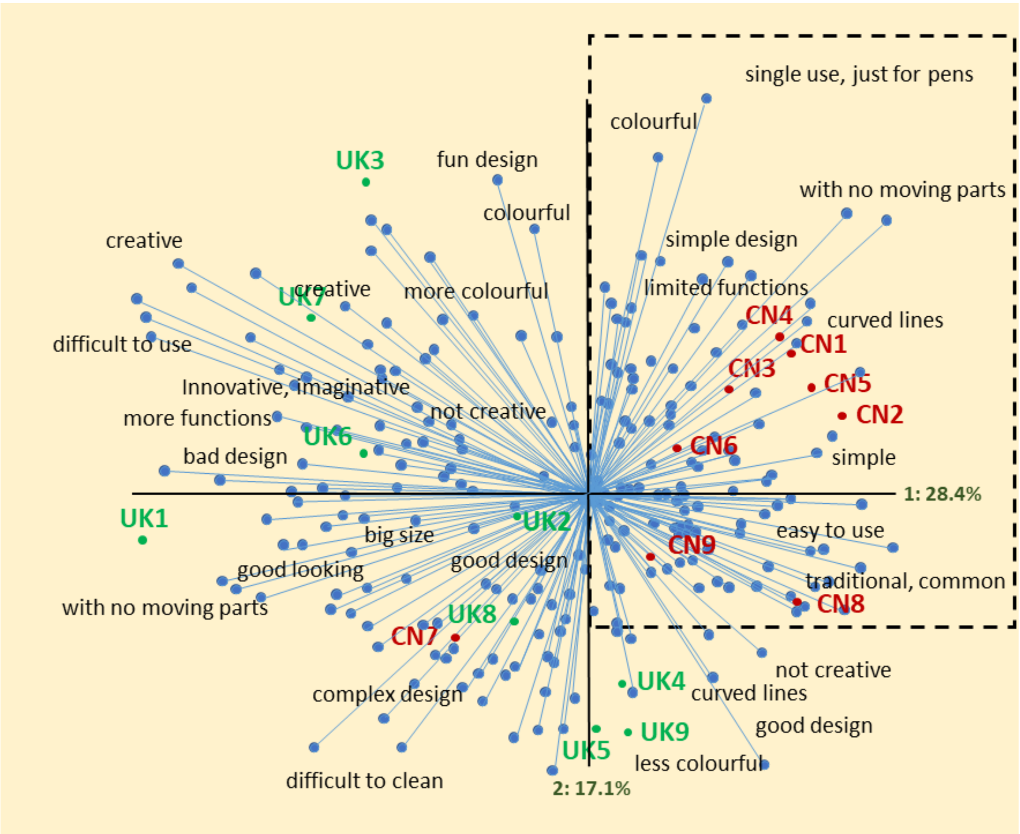

Figure 4. PCA of the grids from the UK group visualised as a biplot – a simplified version (The number of the constructs was cut down to make the graph more readable. The positions of the designs in the graph are labelled with the corresponding design numbers. CN1 – CN9 are Chinese designs and UK1 – UK9 are UK designs. The same below.)

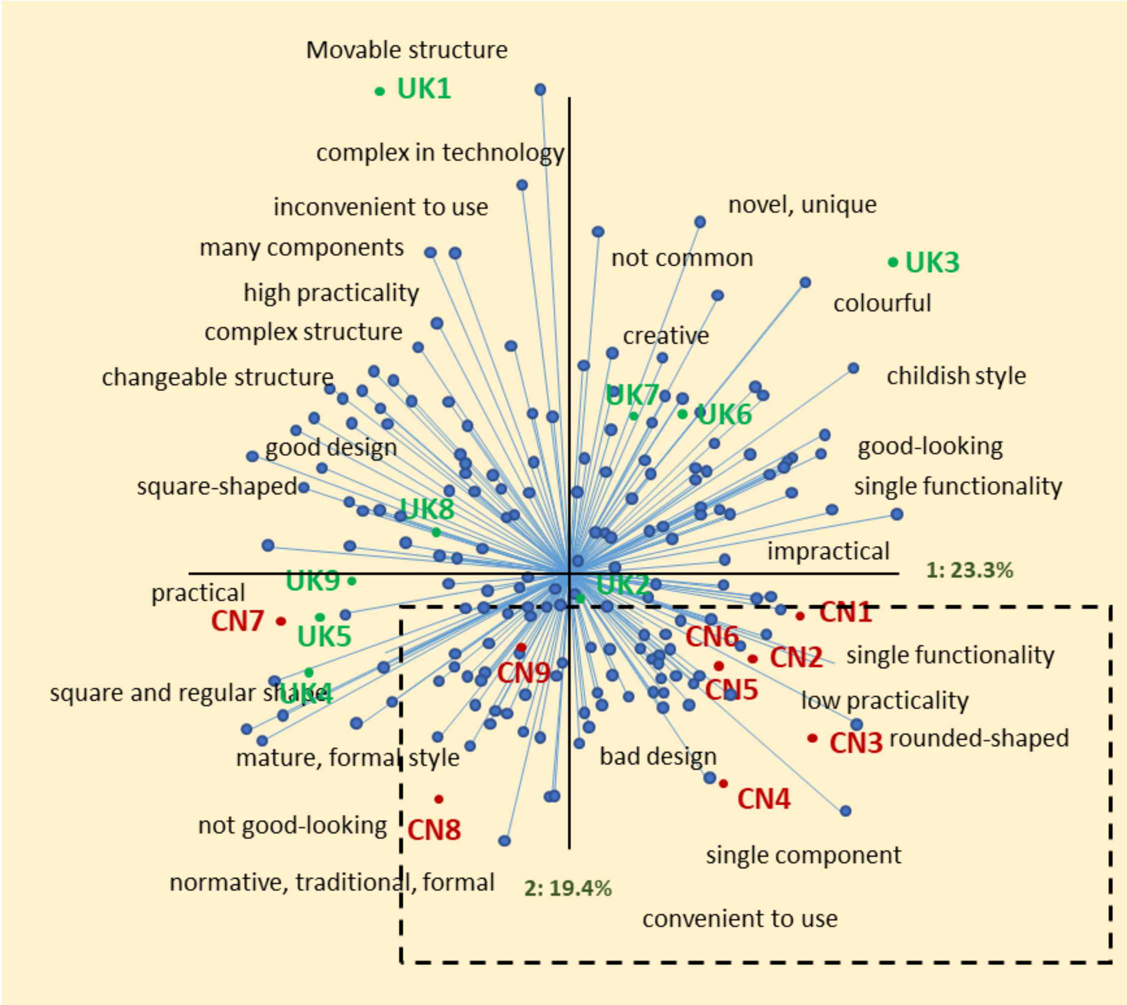

Figure 5. PCA of the grids from the Chinese group visualised as a biplot – a simplified version

The constructs located in the close area where the elements gather indicate the specific attributes that distinguish the elements per se from the elements found located in other areas. The "H" constructs among such constructs of the respective group of designs were collected and presented in Figures 6 and 7.

The results suggest the following: for the UK participants, the UK designs tended to be more aesthetically pleasing and were generally with rounded shapes, fixed structures, a clear pocket design, fewer functions, and less creativity, but were also easier to use/display/clean. To them, the Chinese designs tended to be in square shapes, with more changeable structures and more functions, but no clear pockets. They were also more creative but not necessarily practical to use/display/clean. Overall, the UK participants thought that UK designs were much better than Chinese designs. On the contrary, the Chinese participants tended to find the Chinese designs more aesthetically pleasing, to have complex structures, with more functions and more creativity, taking up more space, and were easier to use/display/clean. To the Chinese participants, the UK designs tended to be simply structured, with small space occupation, much less function, and no creativity, and not easy to use/display/clean. The Chinese participants concluded that the Chinese designs were much better than the UK designs.

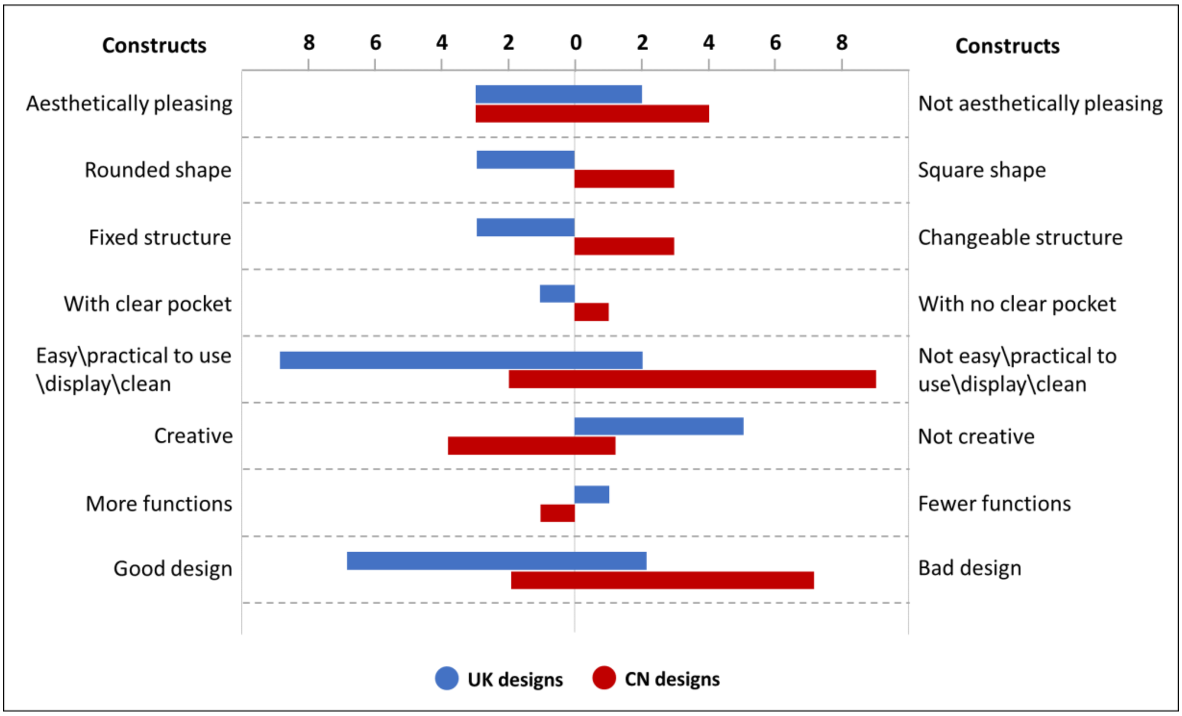

Figure 6 "H" constructs close to the UK and Chinese designs – the UK group (The numbers on the horizontal axis stand for numbers of the corresponding "H" constructs. The same below.)

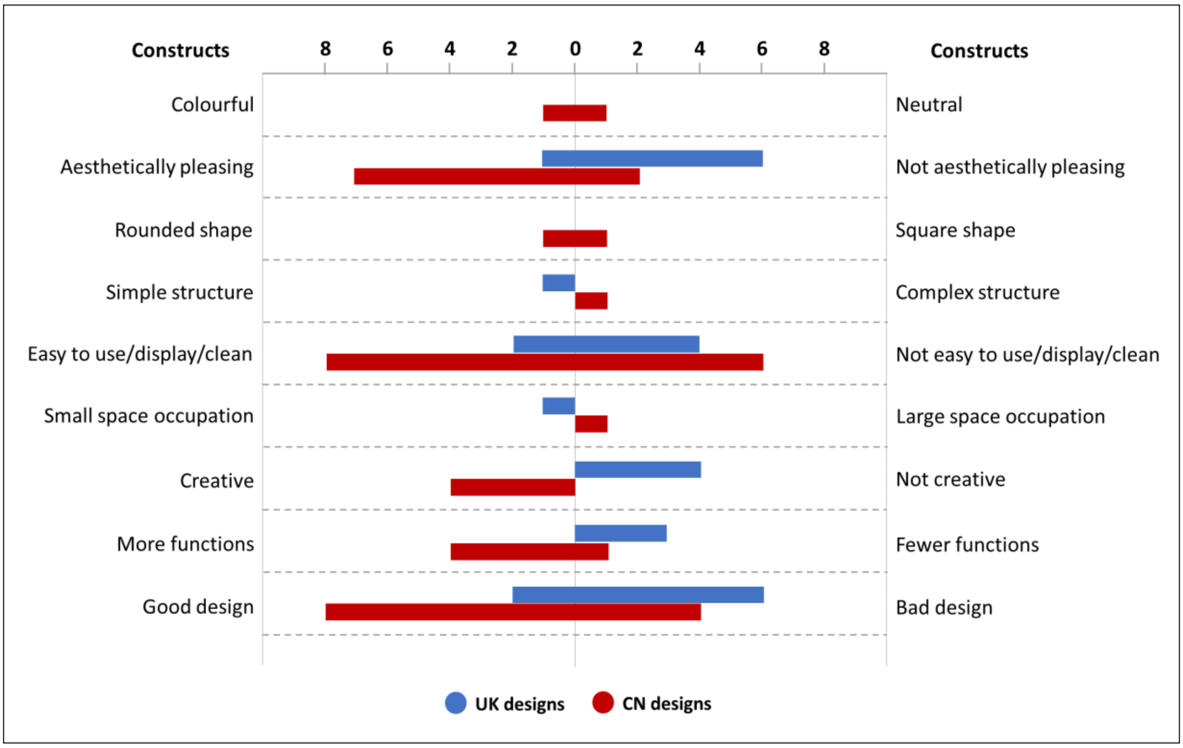

Figure 7 "H" constructs close to the UK and Chinese designs - the Chinese group

Discussion

By applying RG to compare the UK and Chinese designs using UK and Chinese participants, the specifics elements of design evaluations of people from these two cultures were captured and revealed, as were the differences in the designs from the two cultures according to these evaluations. The findings provide empirical evidence on the interplay between culture and design. Also, the application of RG, together with the technique of HCA and CPA, helped with the integration of the qualitative and quantitative data collection and remedies some limitations of the traditional interview method.

The Role of Culture in Design and Design Evaluation

The analysis of the relationships between the elements revealed the distinctive attributes between the UK and Chinese students' designs as have been stated in the results part. Furthermore, from the perspective of design eualuation, the analysis of the relationships between the constructs as well as the "H" constructs suggests that there is no differences in the criteria of design evaluation adopted by the two groups. Both the UK and Chinese participants tended to evaluate a similar range of factors, including aesthetics, form/shape, usability, creativity, and functionality. Also, they tended to put equal weightings on these factors. For instance, aesthetics, form/shape, and usability were the most concerning aspects of the designs.

However, the differences captured in the elements' relationships in the two supergrids revealed that the two groups of participants tended to identify and value with the designs from their own cultures. The result suggests that the two groups tended to consider different attributes of the designs when applying the criteria mentioned above. For example, the UK participants tended to value the designs with rounded shapes. They also appreciated simple designs with a fixed structure, fewer functions and not much creativity. In contrast, Chinese participants tended to value the designs with more complex structure, more functions and more creativity. The designs from each culture were found to inherently maintain these valued attributes and were therefore more appealing to the people from the same cultural background. Such findings have empirically approved the statement that culture plays an essential role in information exchange between designer and intended users (Razzaghi et al., 2009).

Educational Implications

The findings that reveal the interplay between culture and design also suggest implications for design education. First, they have empirically confirmed that the unconsciously implemented cultural attributes in a design could play a vital part in the interaction between it and its users, highlighting the importance of integrating culture in design education. It is coherent with the literature which suggests that for designers, to "foster a sense of cultural sensitivity" and "engender the embodiment of cultural content" will enhance a product's appeal for as well as deepen and further enrich the corresponding experiences of the respective consumers (Razzaghi et al., 2009, p. 458).

Second, which may sound like a contradiction of the first one – the findings also imply that the ability to embody such implicit cultural elements into designs seems not to be directly related to the respective design education. The two groups of design students in the current research were educated in the same education system, using the same learning material; nevertheless, there were still catchable differences in their design work in cross-cultural evaluation. It is reasonable to deduce that such differences were not the direct outputs of the design education the students had received. In the specific design program, there was no course related to the topic of culture. The role of culture in the students' design activities was a more subtle influencing factor rather than an overt theme. This is consistent with the nature of the core of culture, i.e. the implicit values that determine people "tendencies to prefer certain states of affairs over others" (Hofstede et al., 2010, p. 9). Nevertheless, it does not reject the necessity of integrating culture into design education but rather clarifies how to do it. Scholars have claimed that culture is learned rather than inherent (Ashton and Deng, 2010; Hoyos et al., 2015). The manifestation of culture in design could be implicit and unconscious. However, the learning of culture could be planned in an explicit way. An efficient way for designers to learn the culture and integrate it into their designs is to engage and immerse deeply in the target culture. As Hsieh et al.'s (2017) study has proved, engaging the local community on students' design process would allow them to learn to transfer abstract culture into practical design creation. Such a conclusion is also endorsed by Schudson's (1989) theory about how culture works (1989). Schudson claimed that the retrievability of culture concerns with space and time and culture works better "if it is brought into the physical presence of a potential audience" (p. 163). By engaging the students directly with the target culture, the corresponding cultural retrievability would be expanded to a great extent and therefore allows the students to manipulate cultural elements more efficiently.

Nevertheless, there is a long way to go to apply such a pattern to today's design education. The first step is to emphasise the cultural dimension in design (e.g. in Manzini, 2016) and raise people's awareness of the importance of integrating culture in design education. Only on such a premise would the corresponding efforts and measures be applied to reform the design education.

The Application of RG

This study contributes to research by examining the relationship between culture and design in qualitative and quantitative ways. One contribution is integrating the qualitative and quantitative data collected from RG to get a comprehensive understanding of the profound implication of the participants' verbal descriptions. As Höft et al. (2019, p. 346) pointed out, both kinds of data contain different information on the interviewees' construing of the world. A partial analysis of only one type of data would lose the available information. The current paper applies the technique of HCA, which not only generalises the idiosyncratic constructs of each participant but also gives priorities to them. It also solves the limitation of RG highlighted by Hassenzahl and Wessler (2000) about the uselessness of descriptive constructs and the undetermined relations between the constructs. By comparing the differences among the overall rating and all other ratings, the relationships between each construct and the overall construct were revealed. The most relevant constructs on evaluating good vs bad design were identified and further used in the group constructs to understand the underlying reasons for the distinctive categorisation of the two groups of designs. In such a case, the useless descriptive constructs that Hassenzahl and Wessler suggested could be a valuable information pool to understand further the profound implication of each construct in design evaluation, especially in a cross-cultural context.

Another creative application of RG of the current paper is the application of the method of PCA in analysing the group constructs. By applying the two supergrids consisting of the respective UK/Chinese participants' constructs of evaluating the designs, the distinctive patterns were evident in the PCA biplots, which is also a surprising finding of this study. As Höft et al. (2019, p. 353) pointed out, when applying PCA to many constructs, the outcome will depend solely on the quantitative information carried by the ratings but loose "the functional properties of the meaning structures." However, the integration of HCA with PCA has made up such defects. By collecting and interpreting the "H" constructs locating close to the gathering area of the designs, the essential attributes of the respective designs were revealed. The integration of PCA and HCA allows us to understand the fact that there are distinctive differences between the UK and Chinese designs and show how they distinct from each other.

Limitations and Future Research

Certain limitations must be taken into account when interpreting the results. First, being a cross-cultural comparison study, the available design work appropriate for such comparison was different to find and was therefore in a relatively small number. The patterns identified in the PCA graph are consequently based on such a small sample size. Nevertheless, the message it conveys is powerful, as the differences between the two groups of design are very distinctive for both groups of people. Also, the participants of the current research, i.e. the students and the participants to evaluate the designs, were all recruited from one city of the UK (Nottingham) and China (Ningbo) respectively. Therefore the UK and Chinese culture are generalised to a certain extent in the current research. For future work, more efforts could be distributed to involve participants from a wider range of backgrounds from each side to validate the findings.

Second, as the students' collected design work was about a stationery rack for 14 to 18 years old students, the identified attributes are therefore confined to the nature of the design subject. For different types of products, further considerations are needed instead of simply adopting the suggested elements or patterns (e.g. rounded shapes vs square shapes). Also, the identified differences in consumer evaluation and the design attributes relate more to the categories generated by the content analysis, rather than directly exploring the information elicited from individual grids. Further research is needed to apply RG's laddering procedure in a more sophisticated way to get more detailed information from the two perspectives, respectively.

Third, the application of PCA on the two supergrids revealed the distinctive differences between the UK and Chinese designs; nevertheless, it is also undeniable that such method could still lose some valuable information. As in PCA of a large grid, there are more independent dimensions due to a large number of constructs. The CPA biplot only visualises the two principal components, which take over only 42.7% (the Chinese grid) and 45.5% (the UK grid) of the overall grid respectively in this study. The information carried by other independent dimensions was neglected, which could also contain some valuable information in interpreting the corresponding differences. Further research may consider applying other methods such as Clutter Analysis (Easterby-Smith 1980; Höft et al. 2019) to complement the missing information.

Conclusion

It is undeniable that culture plays a hidden role in design and design evaluation, and such a role is essential in harmonising the designer's intention and consumer's response. The current research suggests the integration of the methods of HCA and PCA to analyse both the quantitative and qualitative data collected in RG to reveal the influence of culture empirically. It explored and specified the differences in designs and the criteria for evaluating designs from the UK and Chinese cultures. People from the two cultures were found to value similar aspects of a design, including aesthetics, form/shape, usability, creativity, and functionality, but also tend to apply different criteria in judging these aspects. Designers were found to embody their cultural features unconsciously, and such features play an essential role in the interaction between the design and its users. Such findings highlight the necessity of integrating culture in design education and hint that a possible way to cultivate students' ability to transfer abstract culture into practical designs is to immerse them in the target culture.

Reference

Ashton, P., & Deng, J. Y. (2010). An Investigation of the Transferability of Design Management Education from the UK to China. *Design Management Journal*, *3*(1), 8–16. https://doi.org/10.1111/j.1948-7177.2008.tb00001.x

Brett, J. M., Tinsley, C. H., Janssens, M., Barsness, Z. I., & Lytle, A. L. (1997). New approaches to the study of culture in industrial organizational psychology. In *New perspectives on international industrial organizational psychology*. San Francisco: New Lexington Press.

Chiu, L.-H. (1972). A Cross-Cultural Comparison of Cognitive Styles in Chinese and American Children. *International Journal of Psychology*, *7*(4), 235–242. https://doi.org/10.1080/00207597208246604

Creusen, M. E. H. (2004). The Different Roles of Product Appearance in Consumer Choice. *Journal of Product Innovation Management*, *22*(1), 63–81. https://doi.org/10.1111/j.0737-6782.2005.00103.x

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. https://doi.org/10.1016/j.destud.2004.03.001

Easterby-Smith, M. (1980). The design, analysis and interpretation of repertory grids. *International Journal of Man-Machine Studies*, *13*(1), 3–24.

Fallman, D., & Waterworth, J. (2005). Dealing with User Experience and Affective Evaluation in HCI Design : A Repertory Grid Approach. In *CHI 2005*.

Fallman, D., & Waterworth, J. (2010). Capturing User Experiences of Mobile Information Technology with the Repertory Grid Technique. *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments*, *6*(2), 250–268. 10.17011/ht/urn.201011173094

Fransella, F. (1977). The Measurement of Intrapersonal Space of Grid Technique (Book Review). *British journal of psychology*, *68*(4), 522.

Fu, Y., Jiang, H., Zhang, D., Zhang, X., & Gero, J. S. (2016). Exploring the Differences Between Users' and Designers' Perceptions of App Interface Design: A Case Study of Illumination Dimming and Control Application. In *the ASME 2016 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* (pp. 1–9). Charlotte, North Carolina. https://doi.org/10.1115/detc2016-59521

Gaver, B., Dunne, T., & Pacenti, E. (1999). Design: Cultural probes. *Interactions*, *6*(1), 21–29. https://doi.org/10.1145/291224.291235

Hansen, K. T. (2004). The World in Dress: Anthropological Perspectives on Clothing, Fashion, and Culture. *Annual Review of Anthropology*, *33*(1), 369–392. https://doi.org/10.1146/annurev.anthro.33.070203.143805

Hassenzahl, M., & Wessler, R. (2000). Capturing Design Space From a User Perspective: The Repertory Grid Technique Revisited. *International Journal of Human-Computer Interaction*, *12*(3), 441–459. https://doi.org/10.1207/S15327590IJHC1203&4_13

He, J., & Wang, C. L. (2017). How global brands incorporating local cultural elements increase consumer purchase likelihood: An empirical study in China. *International Marketing Review*, *34*(4), 463–479. https://doi.org/10.1108/IMR-08-2014-0272

Herrando, C., Jiménez-Martínez, J., & Martín-De Hoyos, M. J. (2019). Social Commerce Users' Optimal Experience: Stimuli, Response and Culture. *Journal of Electronic Commerce Research*, *20*(4), 199.

Hesse-Biber, S., Leavy, P., Quinn, C. E., & Zoino, J. (2006). The mass marketing of disordered eating and Eating Disorders: The social psychology of women, thinness and culture. *Women's Studies International Forum*, *29*(2), 208–224. https://doi.org/10.1016/j.wsif.2006.03.007

Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). *Cultures and Organizations Software Of The Mind*. *Cultures and Organizations* (3rd Ed.). New: MsGraw-Hill.

Hofstede, Geert. (2006). What did GLOBE really measure? Researchers' minds versus respondents' minds. *Journal of International Business Studies*, *37*(6), 882–896.

https://doi.org/10.2307/4540391

Höft, N., Heckmann, M., & Jankowicz, D. (2019). Systematic Integration of Quantitative Measures into the Qualitative Content Analysis of Constructs. *Journal of Constructivist Psychology*, *32*(4), 345–369. https://doi.org/10.1080/10720537.2018.1515044

Hoyos, C. M., Scharoun, L., & Poplin, J. (2015). the Importance of Cross-Cultural Learning in the Design Disciplines: a Case Study Reviewing a Series of Short Term Study Tours Designed To Support Cross-Cultural Exchange in the Asia-Pacific Region. *International Journal of Arts & Sciences*, *8*(5), 435–442.

Hsieh, H. C., Huang, C. Y., & Zhuang, Y. C. (2017). A study on the integration of local culture into design aesthetics education-An example of Shalu Papora Community. In *IEEE International Conference on Applied System Innovation* (pp. 645–648).

Jankowicz, D. (2003). *The Easy Guide To Repertory Grids*. Chichester: Wiley.

Ji, L. J., Peng, K., & Nisbett, R. E. (2000). Culture, control, and perception of relationships in the environment. *Journal of personality and social psychology*, *78*(5), 943–955. https://doi.org/10.1037/0022-3514.78.5.943

Kelly, G. (1955). *A Theory of Personality: The psychology of personal constructs*. New York: Norton.

Kroeber, A. L., & Kluckhohn, C. (1952). *Culture: a critical review of concepts and definitions*. Cambridge, MA: Peabody Museum.

Kuru, A. (2016). Cross impact analysis: an alternative way of qualitative data analysis of repertory grid technique. *J. of Design Research*, *13*(4), 362. https://doi.org/10.1504/jdr.2015.074148

Lake, A. J., Staiger, P. K., & Glowinski, H. (2000). Effect of Western culture on women's attitudes to eating and perceptions of body shape. *International Journal of Eating Disorders*, *27*(1), 83–89. https://doi.org/10.1002/(SICI)1098-108X(200001)27:1<83::AID-EAT9>3.0.CO;2-J

Lotz, N., & Sharp, H. (2017). The Influence of Cognitive Style, Design Setting and Cultural Background on Sketch-Based Ideation by Novice Interaction Designers. *The Design Journal*, *20*(3), 333–356. https://doi.org/10.1080/14606925.2017.1301039

Manzini, E. (2016). Design Culture and Dialogic Design. *Design Issues*, *32*(1), 52–59. https://doi.org/10.1162/DESI

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, *98*(2), 224–253.

https://doi.org/10.1037/0033-295X.98.2.224
McCracken, G. (1986). Culture and Consumption: A Theoretical Account of the Structure and Movement of the Cultural Meaning of Consumer Goods. *Journal of Consumer Research*, *13*(June), 71–84. https://doi.org/10.1086/209048
Miller, M. N., & Pumariega, A. J. (2001). Culture and Eating Disorders: A Historical and Cross Cultural Review. *Psychiatry*, *64*(2), 93–110. https://doi.org/10.1521/psyc.64.2.93.18621
Moon, H., Miller, D. R., & Kim, S. H. (2013). Product design innovation and customer value: Cross-cultural research in the United States and Korea. *Journal of Product Innovation Management*, *30*(1), 31–43. https://doi.org/10.1111/j.1540-5885.2012.00984.x
Moura, F. T., Singh, N., & Chun, W. (2016). The influence of culture in website design and users' perceptions: Three systematic reviews. *Journal of Electronic Commerce Research*, *17*(4), 312–339.
Mugge, R., Dahl, D. W., & Schoormans, J. P. L. (2018). "What You See, Is What You Get?" Guidelines for Influencing Consumers' Perceptions of Consumer Durables through Product Appearance. *Journal of Product Innovation Management*, *35*(3), 309–329. https://doi.org/10.1111/jpim.12403
Niinimäki, K. (2010). Eco-Clothing, consumer identity and ideology. *Sustainable Development*, *18*(3), 150–162. https://doi.org/10.1002/sd.455
Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and Systems of Thought. *Psychological Review*, *108*(2), 291–310.
Norman, D. (2012). Does culture matter for product design? https://www.core77.com/posts/21455/does-culture-matter-for-product-design-21455. Accessed 2 December 2020
Parrish, P., & Linder-vanberschot, J. A. (2010). Challenges of Multicultural Instruction; Addressing the Challenges of Multicultural Instruction. *International Review of Research in Open and Distance Learning*, *11*(2), 1–19.
Passini, S. (2013). A binge-consuming culture: The effect of consumerism on social interactions in western societies. *Culture & Psychology*, *19*(3), 369–390. https://doi.org/10.1177/1354067X13489317
Razzaghi, M., & Ramirez, M. (2009). Cultural affordance of products: coverage within industrial design education. *Proceedings of the 11th International Conference on Engineering and Product Design Education EPDE09*, (September), 483–488.

Razzaghi, M., Ramirez, M., & Zehner, R. (2009). Cultural patterns in product design ideas: comparisons between Australian and Iranian student concepts. *Design Studies*, *30*(4), 438–461. https://doi.org/10.1016/j.destud.2008.11.006

Scharoun, L., Peng, F., & Turner, B. (2016). Global creative competency: Multi-disciplinary and cross-cultural workshops as a means to strengthen work-ready skills for Honours students in creative arts & design. In *Australian Council of University Art and Design Schools Annual Conference* (pp. 1–21).

Schudson, M. (1989). How culture works - Perspectives from media studies on the efficacy of symbols. *Theory and Society*, *18*(2), 153–180. https://doi.org/10.1007/BF00160753

Schwartz, S. H. (1992). Universals in the Content and Structure of Values: Theoretical Advances and Empirical Tests in 20 Countries. *Advances in Experimental Social Psychology*, *25*(C), 1–65. https://doi.org/10.1016/S0065-2601(08)60281-6

Seva, R. R., & Helander, M. G. (2009). The influence of cellular phone attributes on users' affective experiences: A cultural comparison. *International Journal of Industrial Ergonomics*, *39*(2), 341–346. https://doi.org/10.1016/j.ergon.2008.12.001

Snelders, D., Morel, K. P. N., & Havermans, P. (2011). The cultural adaptation of web design to local industry styles: A comparative study. *Design Studies*, *32*(5), 457–481. https://doi.org/10.1016/j.destud.2011.03.001

Süner, S., & Erbuğ, Ç. (2016). Evaluation of construct elicitation as a research method to obtain design-relevant data from children. *Metu Journal of the Faculty of Architecture*, *33*(2), 19–43. https://doi.org/10.4305/METU.JFA.2016.2.2

Tellström, R., Gustafsson, I.-B., & Mossberg, L. (2006). Consuming heritage: The use of local food culture in branding. *Place Branding*, *2*(2), 130–143. https://doi.org/10.1057/palgrave.pb.5990051

Tomico, O., Karapanos, E., Lévy, P., Mizutani, N., & Yamanaka, T. (2009). The repertory grid technique as a method for the study of cultural differences. *International Journal of Design*, *3*(3), 55–63.

Trompenaars, F., & Hampden-Turner, C. (2012). *Riding the waves of culture : understanding diversity in global business* (3rd ed.). London: Nicholas Brealey.

Van Boeijen, A., Sonneveld, M., & Hao, C. (2017). Culture Sensitive Design Education - The Best of All Worlds. In *International Conference on Engineering and Product Design Education*. Oslo and Akershus University College of Applied Sciences, Norway.

Wodehouse, A., & Maclachlan, R. (2014). An exploratory model for understanding culture in student design team idea generation. *Design Journal*, *17*(4), 488–514. https://doi.org/10.2752/175630614X14056185479980

Wood, E. D., & St. Peters, H. Y. Z. (2014). Short-term cross-cultural study tours: impact on cultural intelligence. *International Journal of Human Resource Management*, *25*(4), 558–570. https://doi.org/10.1080/09585192.2013.796315