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Cultural Blindness: Eye-tracking trial of visual attention towards Assistive Technology (AT) product, by students from the UK and Pakistan

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Culture is an influential predictor of the way people use their sensory (visual) perception to derive information through visual stimuli. The discipline of psychology is culturally-bounded, providing the dominant views of western societies, in relation to other cultural perspectives. This western bias in research is often termed cultural blindness. According to Nisbett's model of cognition, individuals from Asian (collectivist) and Western (individualist) societies have bias to employ holistic and analytic visual processing styles, respectively. The stigma or negativity associated with Assistive Technology (AT) products are instigated by the societal perception of the communicative (semantics/meaning) content of those devices. There has been little empirical evidence that shows how individuals from different cultures interact with a given visual of an AT product, whether they are motivated to attend specific component (graphemes) of the product; and, the sequence of the fixation within pre-defined Areas of Interests (AOI) of a visual stimulus. In this study eye-tracking in conjunction with Semantic Differential (SD) scale was used to explore the viewing behaviour of students (n=15) from the UK (individualist) and Pakistan (collectivist). Through data analysis using BeGaze™, the order of the fixations was checked. For the appraisal of identical product representation, the pattern of eye movement was noted to be different across cultural groups. The contradiction was discovered due to the amount of attention allocated to various AOI's. The paper further draws on the concept of 'cultural blindness' to indicate the role of culture in relation to socially acceptable product design.

Keywords: Assistive Technology; Cultural blindness, Cognition, Eye tracking, Product semantics, Visual attention

1 Introduction

The paper will underline some deficits/paucity of design research and practice to provide empirical evidence for underpinning investigation using a multidisciplinary perspective. The pragmatic research paradigm has been used for the extractions of insightful information relevant for design researchers and practitioners and those involved in New Product Development (NPD) process.

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Assistive Technology (AT) products – any, product, item, piece of equipment or a product for the use of disabled people to alleviate their physical capabilities –have been used as a vehicle to check those evidences within the domain of visual perception (psychology) through a cross-cultural viewpoint (Cook & Polgar, 2015; WHO, 2011). This marketing (AT) segment subsidises the economic development of countries, internationally (The Economist, 2014). According to World Health Organization (WHO), more than one billion people has some form of disability (WHO, 2011). The gradual but consistent increase in number of disabled and elderly people has resulted in growing demand of AT products in international market (Asghar, Torrens, & Harland, 2018, 2019; Lucintel, 2017; Newell, 2003; Routhier, Vincent, Desrosiers, & Nadeau, 2003; Sun, Wilson, Schreiber, & Wang, 2017; WHO, 2008, 2016). Subsequently, the international assistive technology market has an estimated worth of approximately $42,360.0 million (around £35,165.0 million) (BusinessWire, 2017).

With over 300 definitions, the notion of the culture has been discussed widely in literature. Williams (1983) stated, 'culture' is one of the most difficult word in English language to define precisely. The interventions concerning cultural perspective of disability tends to describe culture as a set of *beliefs, values, meanings and actions that shape the lives of a collective of people, influencing the ways people think, live and act* (Asghar et al., 2019, p. 2; Ripat & Woodgate, 2011, p. 88). Arguably, culture affects the thinking (cognition) processes at both societal and individual levels (Kastanakis & Voyer, 2014). While culture has been an extensive concept, the division of culture into individualist (Western) and collectivist (Asian) societies is a recurrent approach in studying this notion (Hofstede, 2001; Nisbett, 2003). Both societies have marked differences in terms of the formation of societal structure and their cognitive processes – the way by which individuals know the world (Nisbett, Choi, Peng, & Norenzayan, 2001). The values related to interdependent self-construal, complex social relationships with other members, group harmony, sense of belonging (other-focused emotion), are considered to be the hallmark of collectivist (Asian) societies (Kastanakis & Voyer, 2014; Masuda & Nisbett, 2001; Ripat & Woodgate, 2011). On the contrary, members of individualist (Western) societies exhibit independent self-construal, less complex social affiliation, personal autonomy, control (ego-focused emotions) (Kastanakis & Voyer, 2014; Masuda & Nisbett, 2001; Nisbett, 2003; Nisbett & Masuda, 2003; Ripat & Woodgate, 2011). Regarding cognitive styles, members from collectivist and individualist cultures have been reported to use distinct cognitive styles, holistic and analytical, respectively (Masuda & Nisbett, 2001; Nisbett & Masuda, 2003). Holistic and analytical systems of cognition can be defined as follows:

Analytical cognition embodies:

- A detachment of the object from its context.
- A tendency to focus on attributes of the object in order to assign it to categories.
- A preference for using rules about the categories to explain and predict the object's behaviour.
- Inferences rest in part on decontextualization of structure from content, use of formal logic, and avoidance of contradiction.

Holistic cognition entails;

- An orientation to the context or field as a whole, including attention to relationships between a focal object and the field.
- A preference for explaining and predicting events on the basis of such relationships.
- Experience-based knowledge rather than abstract logic and are dialectical.

- An emphasis on change, a recognition of contradiction and the need for multiple perspectives. (Nisbett & Norenzayan, 2002a, p. 19)

Despite the classification of culture (individualist/collectivist), psychological interventions persist to reflect dominating views of Western societies, in comparison to their counterparts (Asian) (Berry, 2013; Ijzendoorn & Sagi, 2001). The discipline of 'cultural blindness' highlights this prejudice and is often understood as *the incapacity to comprehend how specific situations may be seen by individuals belonging to another culture due to a strict alignment with the viewpoints, outlooks, and morals of one's own society or culture* (Bowers, 2013). The international perspective about the perception of disability by the societal member entails both collectivist and individualist societies. Using the principle of psychology, the term cultural blindness has, thus, been employed for this research to demonstrate the opinion of both societies regarding their perception of disability through associated AT products.

The use of AT products occurs in one's sociocultural environment which could play an imperative role for the acceptance of those product. Despite the increased demand of those devices, AT products are often abandoned (Pape, Kim, & Weiner, 2002; Shinohara & Wobbrock, 2011). This is due to the fact that the meanings assigned to these products do not match against the social and cultural prospects of the targeted user (Asghar et al., 2018, 2019; Pape et al., 2002; Shinohara & Wobbrock, 2011). This parallels with the consideration of more accepted social model of disability, that highlights the importance of society towards disabled person (Barnes, Oliver, & Barton, 2008; Oliver, 1990).

Crilly (2010) has compiled evidence to describe range of artefact's functions. Broadly, the explanation of these key aspects of product functions have been described by Jochen Gros in so-called 'offenbach theory of product language' (Gros, 1976). This conceptual model provides an indication of imperative communicative function (semantic content) of products. According to Krippendorff (2007), product semantics can be defined as a *vocabulary and methodology for designing artefacts in view of the meanings they could acquire for their users and the communities of their stakeholders* (Krippendorff, 2007, p. 03). Within the field of product design, product appearance offers clues for the semantic comprehension of the subject (product) (Crilly, Moultrie, & Clarkson, 2004). Henceforth, social significance coupled with the semantics, the meanings, delivered through cultural coding, are considered as an important predictor that instigates product related stigma (Vaes, 2014; Vaes, Jan, Standaert, & Vaes, 2016).

To address the topic of cultural blindness, practicing industrial designers hold the position to influence the individual's perception to diminish the product related stigma (Vaes, 2014). Meanwhile, those involved in AT product design and development process need to be well aware of the way individuals from diverse cultures appraise AT products. While, the role of engineers is vital for improving the practical functions of the product, yet, designers do not have sufficient evidence to predict and check the societal perception towards the semantic attributes of AT product.

This proposed study elicits insights on cultural difference between the individualist (United Kingdom) and collectivist (Pakistan) and inspects how the cultures affects the societal perception of designed AT product. This preliminary study included eye-tacking trials to capture eye-movement for the semantic, meaning, comprehension of the AT product with student samples from the UK and Pakistan.

Two questions guide this study;

Which visual component (graphemes) of an image of wheelchair designs capture relatively large amount of visual attention?

Are there any difference(s) in the semantic (meaning) assignment/given between individuals immersed in a collectivist or individualist society due to the use of a holistic or analytical cognitive processing of the image?

Eye-tracking was considered to be the most appropriate method to inspect the mechanism of visual perception as it offers insightful information about the way people use their sensory (visual) perception to derive information of the presented visual scene. Additionally, the Semantic Differential (SD) scale was developed to check how the individuals dictate their opinion when evaluating the presented AT product.

2 Method

2.1 Semantic Differential (SD) scale

The Semantic Differential (SD) scale has been reported as a method to measure an individual's perception of semantic content of the subject or concept (Ajani & Stork, 2013; Martin & Hanington, 2012; Osgood et al., 1957; Robson & McCartan, 2016). Formerly developed by Osgood (1957), this technique measures individual's perception of subject typically on a seven-point bipolar rating scale (Martin & Hanington, 2012). Participant's opinion about the subject(s) are assessed on a scale, typically one to seven, in relation with the provided pairs of antonymous adjectives. The response value reflects the positive and negative dimension being associated with the subject, where middle value (04) denotes a neutral position (Osgood, 1964; Osgood et al., 1957). When exploiting this scale in cross cultural innervations, the SD scale yielded three factorial categories, evaluation (good-bad), potency (strength-weakness) and activity (fast-slow) becomes more relevant. Several studies have shown to effectively use SD scale to inspect the issues related to disability and disabled people (Ajani & Stork, 2014; Carneiro et al., 2016; Davis et al., 1999; Fellinghauer et al., 2011). Meanwhile, researchers have been noted to modify and develop their own version (Photo Elicitation Semantic Differential, PESD) of SD scale (Fellinghauer et al., 2011). Based on evidences from previous studies, the SD scale method appears to be an effective way to evaluate a viewer's perception of an artefact or an image.

2.2 Eye tracking

The process of visual perception could be considered as an integral element to inspect the way individual interacts with the presented visual stimuli. The advances in eye-tracking technology enabled researchers to monitor, capture and analyses real-time eye movement of the respondents (Wang & Sparks, 2014). Meanwhile, the interventions using a psychological viewpoint to check the eye movement, combines cognitive processes with eye-tracking technology (Dong & Lee, 2008). From this standpoint, eye-tracking offers insightful information about the cognitive strategies that provide investigators with evidences of viewing patterns, which respondents do not consciously see (Dong & Lee, 2008). Moreover, the review of literature has shown eye-tracking as an effective method to be used in pan-cultural studies (Dong & Lee, 2008; Ho, 2014; Nisbett & Masuda, 2003; Wang & Sparks, 2014).

Considering the efficacy and effectiveness, both (SD scale and eye-tracking) methods are used to achieve the intended objective of this study. For this research, SD scale was developed through a Principal Component Analysis (PCA) for choosing appropriate pairs of antonymous adjectives (see appendix A). For using the SD scale in eye-tracking trial, the

visual layout was adopted from Photo Elicitation Semantic Differential (PESD) scale (Fellinghauer et al., 2011).

The purpose of present study was to answer the question, “Did distinct cognitive style affect the distribution of visual attention and viewing pattern of individuals from diverse cultures, when attending various graphemes of an image of the attendant wheelchair?” This was investigated by eye tracking, where the participant viewing pattern and sequence of fixation is captured, when assigning semantics, the meanings, to the AT product. This approach also suggested the amount of attention paid to each component of the product. For defining Area of Interests (AOI), this study adopted identical methodology as highlighted by Ho (2014). Based on object-oriented and feature-oriented theories of visual attentions, eight (08) attention-based AOI were coded to obtain the information about relevant eye-tracking metrics (Duration of First Fixation (DFF), Fixation Count (FC), Glance Duration (GD) etc.). AOI with their corresponding coded labels are presented in Table 3.

The size and shape of AOIs corresponds to the associated regions of the product (wheelchair). For example, the wheels and backrest AOI are relatively larger than other components of the products. All types of attention-oriented AOI are listed in Table 1 and illustrated in Figure 1.

Table 1: AOI's based on graphemes of the product

Defined Areas of Interest (AOI)	Labelled as
Wheels	A_1
Backrest	A_2
Seat-pan	A_3
Operating Handle (at back)	A_4
Footrest	A_5
Support Wheels (at front)	A_6
Armrest	A_7
Others (metal structure)	A_8



Figure 1: AOI's with coded labels

3 Procedure and post processing

The authors collected 70 images of a generic attendant wheelchair. The images were intended to be as neutral as possible with respect to sociocultural status. This was achieved by removing unnecessary variables (details of users, backgrounds). Of the 70 images, four images were selected based on the image quality, angle of orientation, and image size. The chosen images were further treated to remove any indications of brands. The gender ambiguous outline of an attendant was used to provide visual reference for scale and proportion of the product. Lastly, the non-colour and non-texture preferences were selected to avoid influence on participant’s opinions (Torrens, Storer, Asghar, Welsh, & Hurn, 2019). Figure 02 presents those standardised designs of the product used in the eye-tracking experiment.

For the experiment the authors used a screen based Tracksys supplied SMI (SensoMontric Instrument) eye tracker with an infrared corneal reflection system, integrated into 21.5-inch monitor (at 1680 x 1050 resolution). The SMI RED 120Hz equipment was selected as it gathers information of each 10 milliseconds (ms).



Image 01 Image 02 Image 03 Image 04

Figure 2: Designs of Wheelchairs used for the trials

The Experiment Centre 3.6 computer program in conjunction iView X™ was used to acquire data at the rate of 120 Hz. The distance between the computer screen and participants was ranging from 40cm to 50cm.

The size of the displayed map visual (stimuli) was 1680 x 1050 pixel to match with the monitor resolution. Finally, to acquire the valid data for the study, the experiment using the same equipment was carried out with the participants of the UK and Pakistan.

There were fifteen (n=15) participants in this preliminary study: eight (08) Asian volunteer from Pakistan and seven (07) Western volunteer from the UK. Volunteer from Pakistan sample were all graduate students recruited from University of Engineering and Technology, Lahore, and consisted of equal number of males and female (04 male, 04 female), having an age range between 18 to 21 years. Volunteer in the UK group were all British national graduate students and consisted of four males and three females (mean age 19.2 yrs.) recruited from Design School, Loughborough University, UK. The participants from both groups were matched on age and graduate fields of study. Participants were graduate students from design school in Higher Education's Institution (HEI) from both countries. Prior to data collection, the study received ethical approval from relevant committees of both institutions involved.

All subjects read and signed an informed consent form that had been approved by the Ethics sub committees at the University of Engineering and Technology and at Loughborough University.

Prior to the eye tracking trials, participants completed the demographics questionnaire. All participants were informed that they would be presented with a series of images to evaluate the product for the provided pairs of adjectives. Once sitting comfortably, the participants were asked to maintain their posture without moving their head or face. A calibration was performed followed by five-point validation test. The calibration with .5 degree of X and Y axis was achieved before introducing the mapping visuals. Each image was displayed for a period of 10 seconds (10000 ms). Participants were instructed to utter their response on a scale from one to seven. Figure 03 shows an example of such image used in the eye-tracking.

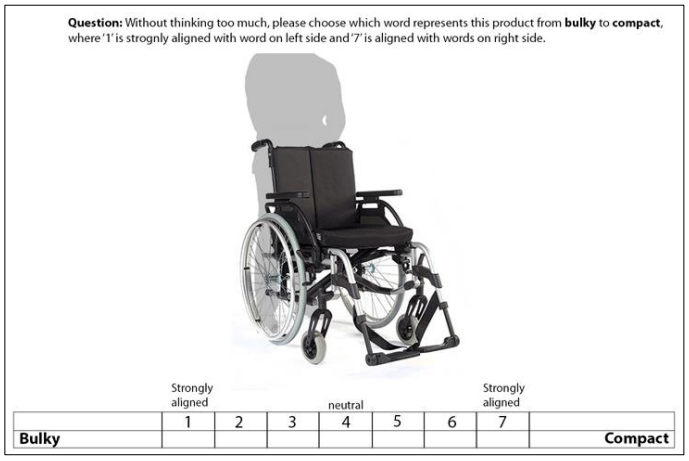


Figure 3: Example of visual stimulus used in experiment

4 Result

The complete dataset associated with this study can be accessed at Figshare (Asghar, 2019). Regarding Duration of First Fixation (DFF) for each AOIs, Table 02 represents the sequence of viewing behaviour in ascending order for Pakistani participants was A_1, A_3, A_2, A_8, A_6, A_5, A_7 and A_4. While, this sequence was noted as; A_1, A_2, A_3, A_8, A_5, A_6, A_7, and A_4, for participants from the UK. With the exception of A_1, the sequence for DFF of participants was discovered as different across the groups. Similar difference of sequence for DFF was recorded for the other designs of wheelchair represented in image 02, image 03 and image 04.

The Fixation Count (FC) in descending order for image 01, for the participants from Pakistan was A_3, A_2 and A_1. This arrangement for FC does not match with the responses of other groups. For which the similar order of FC was noted as; A_8, A_3, A_1, and A_2. The similar fluctuation regarding FC were discovered, when participants were attending the rest of the designs of product (image 02, image 03 and image 04).

Table 2: Eye tracking data metric from the experiment

		Image 01			Image 02			Image 03			Image 04		
		DFF	FC	GD	DFF	FC	GD	DFF	FC	GD	DFF	FC	GD
Pakistan	A_1	164	1.49	428.66	218.15	2.28	746.53	140.60	1.43	475.46	217.7	2.20	737.36
	A_2	91.08	1.21	410.99	146.15	1.13	368.91	105.83	1.36	411.36	91.55	0.66	155.58
	A_3	142.5	0.9	249.73	188.03	1.13	358.45	257.23	2.10	897.03	218.27	1.73	611.05
	A_4	11.82	0.03	10.16	0.00	0.00	0.13	0.00	0.01	6.13	0.00	0.01	5.48
	A_5	18.77	0.05	14.08	41.03	0.28	75.35	62.53	0.25	55.78	63.60	0.23	64.09
	A_6	42.57	0.18	54.6	56.48	0.49	120.05	109.15	0.41	136.75	185.95	0.40	179.35
	A_7	18.25	0.10	23.85	31.28	0.24	95.03	8.35	0.01	6.64	10.60	0.04	13.69
	A_8	55.21	0.39	136.98	75.35	0.74	247.00	105.93	0.43	141.88	84.73	0.41	120.05
UK	A_1	150.23	1.55	605.68	231.87	2.56	789.60	235	2.5	927.05	281.3	3.14	1057.53
	A_2	141.92	1.90	602.01	143.07	1.48	467.79	123.70	1.26	416.53	118.97	1.29	384.75
	A_3	139.07	1.25	507.93	225.87	2.15	761.40	260.17	1.95	731.95	218.80	2.38	695.03
	A_4	0.00	0.01	9.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	A_5	76.43	0.10	62.40	100.90	0.23	105.45	18.00	0.05	18.28	11.90	0.08	24.13
	A_6	36.50	0.28	61.19	128.90	0.39	193.50	14.50	0.08	20.41	69.15	0.40	130.65
	A_7	26.83	0.08	30.40	62.23	0.33	82.15	69.92	0.21	98.46	73.30	0.26	76.85
	A_8	82.82	0.50	190.24	98.11	0.99	361.05	104.91	0.61	234.06	85.76	0.60	193.60

Mean values for 'DFF' and 'GD' are reported in milliseconds (ms).

For the first visual, the participants of both groups attended A_1, with maximum Glance Duration (GD). Regarding total GD, the order of viewing behaviour for participants from Pakistan was recorded $A_2 > A_3 > A_8 > A_6 > A_7 > A_5$ and $> A_4$. In contrast, the participants of other group allocated slightly varied sequence of GD ($A_2 > A_3 > A_8 > A_5 > A_6 > A_7$, and $> A_4$).

Similar trends of fluctuation (in the amount attention paid and recorded through GD) was observed when the participants of both groups were attending homogenous design of the wheelchair. The dissimilar numeral for the variables (DFF, FC, GD) and sequence with which the AOI were attended by the participants endorse the assertion; the distinct cognitive styles of individuals from diverse cultures potentially affects the distribution of visual attention and viewing pattern.

The eye-tracking data (heat maps) revealed further insightful information to inspect the relevance of vital visual graphemes in the product, for the assignment of the meaning(s). The findings from the heatmap suggested that participants of both cultural groups had attended different AOI when evaluating the product. For example, figure 4 shows a comparison of the amount of visual attention being allocated by the participants of both groups. For the appraisal of product between *bulky-compact*, the hotspot (based on the fixation length) was discovered on different AOI.

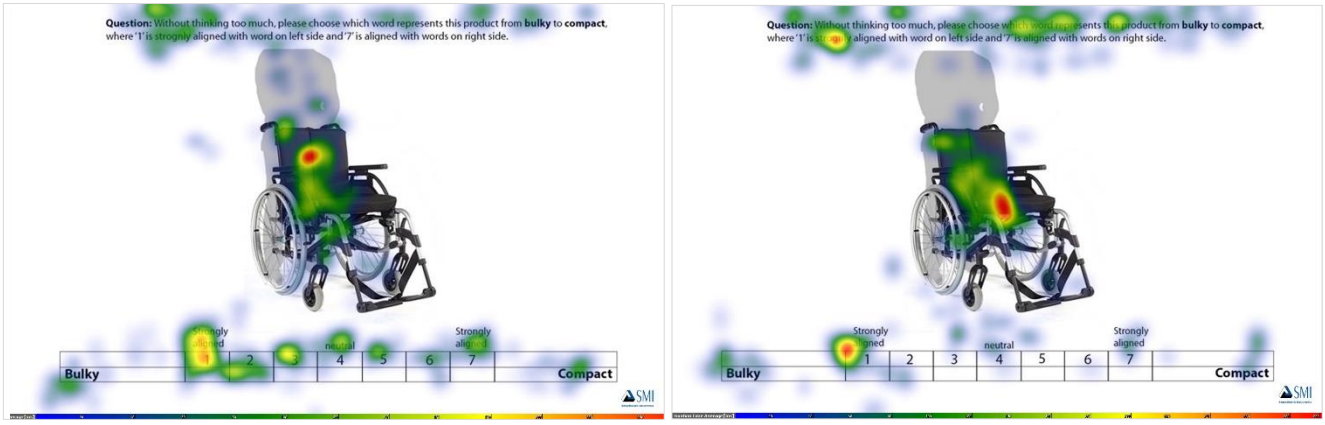


Figure 4: Heatmaps of participants from the UK (right) and Pakistan (left)

Finally, statistical assessments were performed to investigate the nature of overall response from both groups. The mean (M) standard deviation (sd) values of each groups were obtained and analysed. The responses from both groups may not necessarily depend on each other, for which reason, the responses can be considered as 'independent'. Consequently, the Independent sample t-test was performed through Statistical Package for Social Sciences (SPSS) computer program, resulting a reliability (p) value (image 01 (0.023), image 02 (0.04), image 03 (0.001), image 04 (0.0032)) less than 0.05. The p value (<0.05) from statistical analysis further supported the proposition of the difference between the viewing behaviour of individuals from both cultures.

5 Discussion

Previous interventions inspecting visual attention and viewing behaviour to extract information from the presented visual found cultural differences between collectivist (Asians) and individualist (Westerns) (Boland & Nisbett, 2015, 2015; Chua, Boland, & Nisbett, 2005; Markus & Kitayama, 1991; Masuda & Nisbett, 2001; Nisbett & Masuda, 2003).

This study aimed to investigate whether holistic and analytical cognition would be relevant in the context of visual attention during the product's semantic(s) attribution. In an attempt to

address the aim, this study found that Western and Asian perspectives differ in i) how much attention has been paid by the individuals of both groups to various AOIs, when appraising AT product's semantic(s), meaning(s), and ii) how viewing behaviour differs between the groups to attend the visual of an AT product. As noted by Chua *et al.* (2005) and Boland (2015) that differences in the formation of societal structure, experience and expertise may overtly influence the individual's unconscious behaviour (such as eye-movement). This account approves the assumption of cultural influence on cognition and perception. From this, it can be extracted that the distinct cognitive styles of the participants may have mediated their viewing behaviour which resulted to fixate different graphemes of the product. The variations in semantic attribution towards the product further offered authors with empirical evidence of explicit influence of culture on the cognitive processes (appendices B).

In conclusion, the results suggest that there are stable cultural differences in the viewing behaviour of Asian and Western societies. The participants from the UK had longer fixation duration on the product compared to the Pakistani participants, supporting the outcomes of relevant studies (Chua et al., 2005; Nisbett & Masuda, 2003). Likewise, when the UK participants reacted to the product, visual attention was mainly in response to the subject rather than other visual clues (question, rating scale, etc.). While, for Pakistani participants, the visual attention was also distributed on regions other than the focal object. Overall, those findings seem to be consistent with Nisbett (Kastanakis & Voyer, 2014; Nisbett et al., 2001; Nisbett & Norenzayan, 2002b) theories regarding holistic cognition of Asian cultural values and the analytical cognition in Western cultures.

It is important was to note that when evaluating the product for new pairs of adjectives, the viewing pattern of individuals was distributed differently. For instance, for the appraisal of product between *comfortable-uncomfortable*, attention of participants was focused on the seat-pan (A_3). While for other pairs of adjective *attractive-unattractive*, A_1 was reported to be more important than A_3. It provides an indication that people preferences were altered for the semantic comprehension in relation to the different components within the product, which could be further validated/investigated.

A further experiment with large number of young adults from both cultural groups will be accomplished. At this point, the generalisability of the findings from this study is subject to certain limitations. Initially, the small population size considered for this study does not allows the authors to generalise the results. This preliminary study was intended with a limited number of participants, for which reason individual (e.g. gender, age) related influence could not be explored. Another limitation of this research would be the use of pictorial representation of the product in the survey. The use of actual product may produce further insightful results as it would convey more information than that of the visually represented product. However, this preliminary research focuses specifically on the visual aspect of the product using a cross-cultural viewpoint. Therefore, considering the research objective (user-product visual interaction) the use of visuals was considered appropriate for the survey. This research, using a visual of the product rather than the actual product, may also provide an indication for brands, manufacturers and associated stakeholders to check the value, credits and meanings of their products in global online marketplace (e-commerce).

Additional areas for future research may include; similar experiment comparing the opinions of both groups, when presented with coloured/textured designs. Further exploration may conduct semi-structured interview for validating the opinions of participants each group.

6 Appendices

The study provides additional information underpinning investigations in following appendices;

Appendix A: Pairs of antonymous adjectives selected for the study

	Pair of adjectives	***Semantic Attribution***	***Reference***
P1 **P2**	Bulky – Compact Large – Small	Product feature (size)	(Taylor, 2006) (Chaves et al., 2004)
P3	Comfortable – Uncomfortable	Ease of utility	(Chaves et al., 2004), (Mann *et al. 1996)*
P4	Traditional – Modern	Modernity	(Petiot & Yannou, 2004)
P5	Old – New	Modernity	PCA
P6	Hard-to-use – Easy-to-use	Ease of use (usability)	PCA
P7	Practical – Decorative	Product feature (functionality vs language function)	PCA
P8	Attractive – Unattractive	Quality	PCA

PCA: Principal Component Analysis,

Appendix B: Additional results: Comparing responses of both groups



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