EXTENDED REALITY (XR) SURVEY: A CONSUMER TECHNOLOGY ACCEPTANCE PREFERENCE STUDY ON RETAIL

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Extended reality (XR), Consumer preferences, Retail, UK

Introduction

The rapid development of technology is changing the experience of the way people purchase goods. With the rise of three-dimensional holographic technology, the e-tailing market is also facing a transition from two-dimensional to three-dimensional. A representation of 3D technology is extended reality (XR), which is gradually penetrating the entertainment and leisure sector as it continues to evolve. Extended reality includes virtual reality, augmented reality and mixed reality. Virtual reality (VR) represents immersive, interactive, multi-sensory, user-centred, three-dimensional computer-generated environments and the technologies that construct such environments (Aukstakalnis & Blatner, 1992; Cruz-Neira, 1998). Augmented reality (AR) is a range of technologies which integrate real-world and virtual information to enhance a particular reality (Lamantia, 2009). Mixed reality (MR) is defined as an existing display system that displays both real and virtual objects (Milgram and Kishino, 1994). Subsequently, Microsoft (2022) defined mixed reality as an experience that can be transformed between augmented reality and virtual reality.

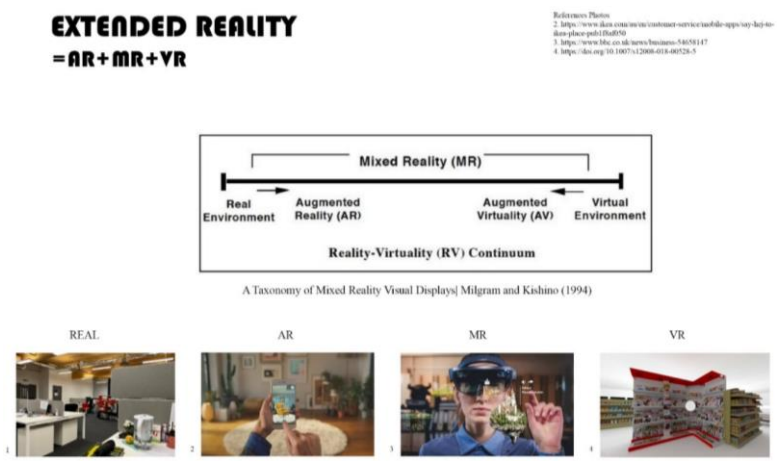

Figure 1. The Differences in Extended Reality

The adoption of extended reality in the retail industry has contributed to a more diverse shopping experience for consumers, reduced retail costs, and increased mobility, availability, and sustainability for retail (Verhoef et al. 2017; Reinartz et al. 2019; van Esch et al. 2019; Bulearca and Tamarjan, 2010). This study was conducted as a pilot study using a questionnaire with 807 participants invited to quantitatively analyse and predict the prospects and opportunities for using extended reality technology in the retail market, to provide a guide and reference for a future sustainable and equitable new digital retail market. We utilise Davis (1993) 's TAM model as a framework and identify additional factors to construct our conceptual model.

Purpose

This study aims to improve user engagement and to understand better user acceptance of extended reality (XR) technologies.

Conceptual framework

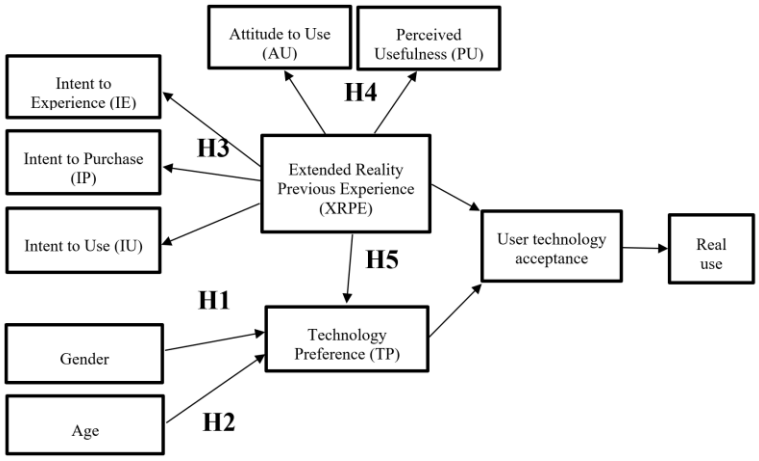

Figure 2. Conceptual Model

The model is based on an extension of Davis's (1993) technology acceptance model. Davis (1989) proposed that TAM could predict user technology acceptance based on the perceived usefulness and perceived ease of use of the technology. The TAM is based on Fishbein and Ajzen's (1975) psychological attitude paradigm, which states that the consequences of a perceived behaviour, which is the potential outcome resulting from performing the behaviour, are an affective evaluation of the behaviour. Venkatesh and Davis (1996) suggest that external variables influence perceived usefulness and perceived ease of use. While attitudes to use may lead to particular behaviours, perceived usefulness is very likely to be an influential factor leading to attitudes to use, and the external factors influencing perceived usefulness would need to discuss.

The TAM only provides an exploration of general technology acceptance; as such, its domain of the retail industry and XR technology could be further explored. This paper proposes that user intentions (intent to use, intent to purchase, and intent to experience), technology preference and previous XR experience influence users' real use of the technology.

Methodology

This study was conducted utilising a semi-structured questionnaire that focused on understanding consumer preferences and acceptance towards the adoption of extended reality technology in retail shopping as the rationale for the design. This section introduces the research questions, hypotheses, participant demographics, questionnaire design, and procedures.

Research Questions

- What are the associations between gender and a previous experience with extended reality?
- What are the associations between age and a previous experience with extended reality?
- What are the relationships between the availability of XR's previous experience on intent to use, intent to purchase and intent to experience?
- What are the relationships between the availability of XR's previous experience on attitude to use and perceived usefulness?
- What are the associations between the availability of XR's previous experience on technology preferences?

Hypotheses

- H1: Genders have significant associations with MR, AR and None; VR has no direct associations.
- H2: Age has significant associations with MR and AR; VR and None have no direct associations.
- H3: Extended reality previous experience has significant associations with intent to use, intent to purchase and intent to experience.

- H4: Extended reality previous experience has highly significant differences in attitude to use and perceived usefulness.
- H5: Extended reality previous experience has significant associations with AR, VR and None, and has no direct significant associations with MR.

Participants Demographics

The survey was conducted in Lancaster, UK. Questionnaires were distributed in the UK and China (identified as Asia in the questionnaire). 878 volunteer participants accepted the invitation, with a sample of 807 available data. Data collection was between May and June 2022. Recruitment methods involved social media; email; digital questionnaires on Qualtrics; posters; snowballing and distributing physical questionnaires on the Lancaster city high street. The questionnaire's geography has four domains: the United Kingdom, Asia, Europe, and Others. The participants' majority come from the UK and China. Participants were recruited through both online and offline sources. UK participant recruitment has two methods, offline distributing paper questionnaires at Lancaster University and Lancaster city centre by posting digital questionnaires on social media. Participants in China were mainly recruited via social media platforms.

Questionnaire

The questionnaire design contains scale questions and non-scale questions. The scale questions are based on the Likert (1932) five points scale. Non-scale questions combine single-choice, multiple-choice questions, and question responses. The questionnaire structure is in the order of the user persona, with the scale questions interspersed with single-choice and multiple-choice questions. Four scale questions show the Cronbach α coefficient is 0.83, indicating that the study data is of high-reliability quality. The CITC values of the analysed items were all greater than 0.4, indicating a good correlation between the analysed items and a good level of reliability.

Procedures

The process is identical for all participants, who are required to complete between fifteen and seventeen questions, two of which skip logic. Participants are required to read the definition of extended reality technology in the introduction to the questionnaire prior to noting their response. In the offline recruitment, participants are given a small pack of sweets as an incentive end of the survey.

Findings

Hypothesis 1. Genders have significant associations with MR, AR and None; VR has no direct associations.

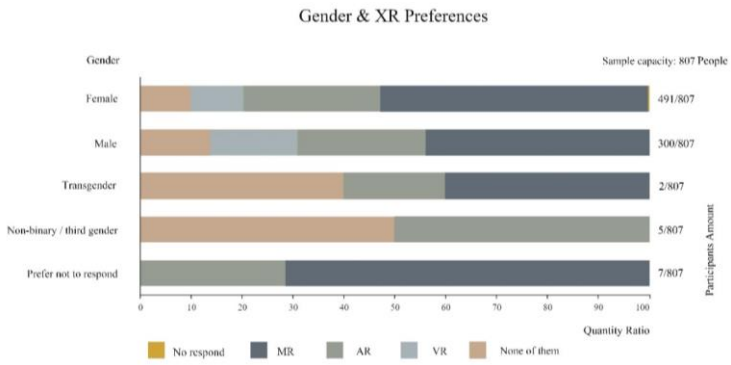

Figure 3. Gender Versus XR preferences

Pearson Chi-square Analysis (N)							
Items	Categories	Gender			Total	X^2	P
		Female	Male	Non-binary/third gender			
MR	0.0	231	167	3	401	6.251	0.044*
	1.0	257	129	2	388		
Total		488	296	5	789		
AR	0.0	424	226	5	655	15.53	0.000***
	1.0	64	70	0	134		
Total		488	296	5	789		
VR	0.0	341	203	3	547	0.351	0.839
	1.0	147	93	2	242		
Total		488	296	5	789		
None	0.0	439	255	3	697	6.52	0.038*
	1.0	49	41	2	92		
Total		488	296	5	789		
*$p<0.05$ **$p<0.01$ ***$p<0.001$							

Table 1. Gender and XR Preferences Chi-square Analysis

In the table, the option was selected indicated by 1 and unselected is 0. Transgender is less than 5, thus, it would not include in analyse. Gender does not show significant associations with VR ($p>0.05$). In contrast, the Gender sample shows significant associations with MR and None of them ($p<0.05$). AR has an extremely significant association with gender. Therefore, MR, AR and None reject the null hypothesis, and VR fails to reject the null hypothesis. (H0≠H1)

MR, $Chi= (df=2, n=789) = 6.251, p<0.05.$

None, $Chi= (df=2, n=789) = 6.52, p<0.05.$

AR, $Chi= (df=2, n=789) = 15.53, p<0.001.$

VR, $Chi= (df=2, n=789) = 0.351, p>0.05.$

Females most prefer MR. 52.66% (F) > 49.17% (mean) > 43.58% (M) > 40% (non-binary). Males prefer AR. 23.65% (M) > 16.98 (mean) >13.11% (F) > 0.00% (non-binary). VR shows consistency ($p>0.05$). For those who chose None, 13.85% (M) > 11.66% (mean) > 10.04% (F) > 4% (non-binary).

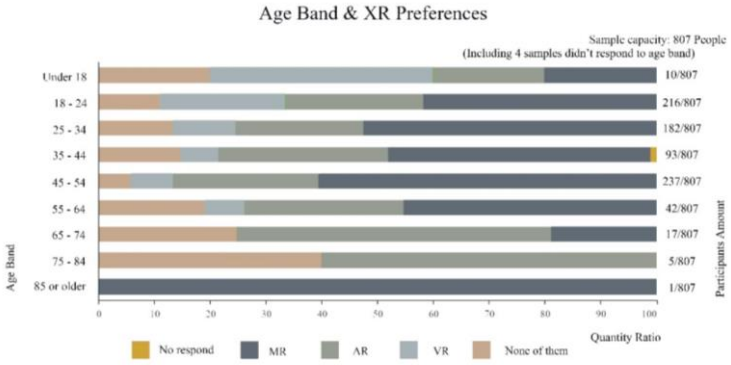

Figure 4. Age Versus XR preferences

The preference for MR gradually increases with age, peaking at the age band 45-54, then declining sharply. It is also starting in this age group that the reluctance to use any extended reality technology is proliferating. Overall, a significantly lower proportion chose to use VR in retail purchases. It is therefore speculated that mixed reality is often chosen due to its unique blend of immersion and engagement with the real world. Virtual reality, by contrast, is considered to be excessively immersive and unrealistic.

Hypothesis 2. Age has significant associations with MR and AR; VR and None have no direct associations.

Chi-Square Analysis (%)

Items	Categories	Age									Total	χ^2	p
		Under 18	18-24	25-34	35-44	45-54	55-64	65-74	75-84	85 or older			
MR	0.0	80.00%	58.26%	47.49%	50.00%	41.03%	54.76%	81.25%	100.00%	0.00%	50.56%	30.069	0.000**
	1.0	20.00%	41.74%	52.51%	50.00%	58.97%	45.24%	18.75%	0.00%	100.00%	49.44%		
Total		10	218	179	92	234	42	16	5	1	797		
AR	0.0	60.00%	69.27%	82.68%	91.30%	91.45%	90.48%	100.00%	100.00%	100.00%	83.19%	55.890	0.000**
	1.0	40.00%	30.73%	17.32%	8.70%	8.55%	9.52%	0.00%	0.00%	0.00%	16.81%		
Total		10	218	179	92	234	42	16	5	1	797		
VR	0.0	80.00%	68.35%	70.39%	64.13%	73.50%	66.67%	43.75%	40.00%	100.00%	69.26%	11.329	0.184
	1.0	20.00%	31.65%	29.61%	35.87%	26.50%	33.33%	56.25%	60.00%	0.00%	30.74%		
Total		10	218	179	92	234	42	16	5	1	797		
None	0.0	80.00%	88.99%	86.59%	89.13%	92.31%	80.95%	75.00%	60.00%	100.00%	88.46%	14.060	0.080
	1.0	20.00%	11.01%	13.41%	10.87%	7.69%	19.05%	25.00%	40.00%	0.00%	11.54%		
Total		10	218	179	92	234	42	16	5	1	797		

*** p<0.05 ** p<0.01**

Table 2. Age and XR Preferences Chi-square Analysis

Age bands show consistency for VR and None, and the Age band show extremely significant associations for MR and AR ($p<0.001$). The probability of choosing MR in the age range of 25-54 is greater than the mean of 49.44%. The probability of choosing AR was greatest between the ages of under 18 to 34. ($H0 \neq H1$).

Hypothesis 3. Extended reality previous experience has significant associations with intent to use, intent to purchase, and intent to experience.

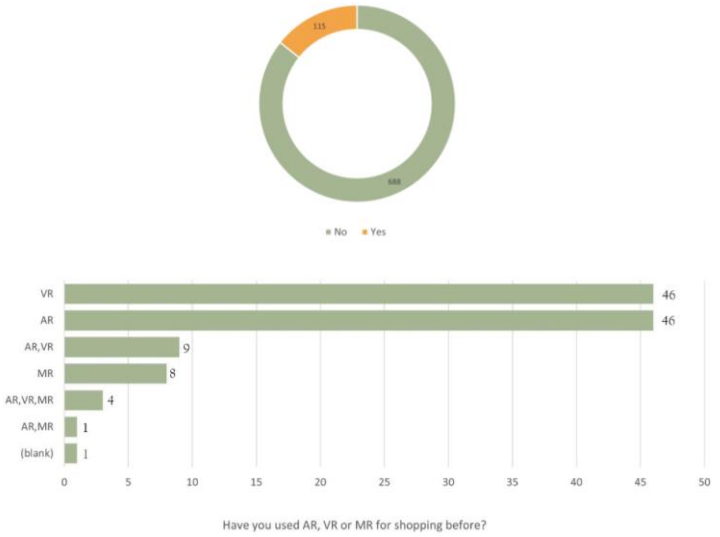

Figure 5. Extended Reality Previous Experience (XRPE)

85.7% of participants had not used XR purchasing, while 14.3% reported previously using at least one of them. The minimum number of MR usage reflects that it has not been popularised in the practical applications in retail purchases that have been developed and that the devices are less accessible in public dominant.

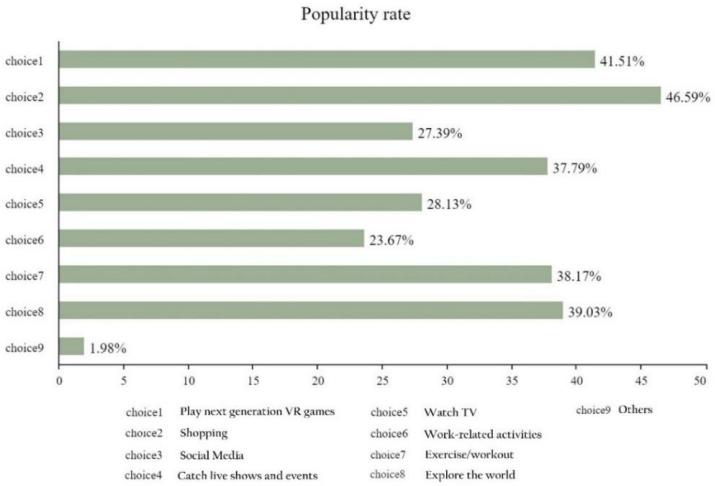

Figure 6. VR/MR Intent to Use (multi-choice)-Popularity Rate

The popularity rate of intent to use VR/MR devices illustrates that most participants chose shopping as their intent of use, with 46.6% of participants. Followed by playing next-generation games with 41.5% of participants.

The table below analyses the associations, XR previous experience (XRPE) as the independent variable, and intent to use (IU), intent to purchase (IP) and intent to experience (IE) as the dependent variable.

Chi-Square Analysis						
Items	**Categories**	**XRPE**		**Total**	χ^2	*p*
		Yes	No			
IU. Shopping	0.0	40.00%	55.67%	53.42%	9.722	0.002**
	1.0	60.00%	44.33%	46.58%		
Total		115	688	803		
IU. Live show	0.0	53.04%	63.66%	62.14%	4.723	0.030*
	1.0	46.96%	36.34%	37.86%		
Total		115	688	803		
IU. Exercise	0.0	51.30%	63.66%	61.89%	6.380	0.012*
	1.0	48.70%	36.34%	38.11%		
Total		115	688	803		
IP. Clothes	0.0	20.00%	32.41%	30.64%	7.144	0.008**
	1.0	80.00%	67.59%	69.36%		
Total		115	688	803		
IP. Furniture	0.0	43.48%	53.78%	52.30%	4.191	0.041*
	1.0	56.52%	46.22%	47.70%		
Total		115	688	803		
IE. Customisation	0.0	42.61%	54.22%	52.55%	5.323	0.021*
	1.0	57.39%	45.78%	47.45%		
Total		115	688	803		
***p*<0.05 ** *p*<0.01**						

Table 3. Associations in XRPE, with IU, IP and IE (click to see the full table)

The table demonstrated that a total of six items showed significant associations ($p<0.05$), and the remaining 17 items had no direct significant associations ($p>0.05$). (H0=H1).

The difference between those with previous experience with XR and those who purchased clothes was highly significant associations ($p<0.01$). 44.33% chose to shop but had no previous experience. 80% of the group that had used XR to shop chose to use it to purchase clothes, while 67.59% of the group that had not used it also chose clothes as their purchase intention. Overall, of the six items with significant variability, the degree of intent to use XR shopping by consumers who had experienced was Shopping > Exercise > Live shows = Explore the world. Consumers who had not used XR purchases had the intention to use the preference of Shopping > Playing games. Therefore, in these six items, experienced users held greater enthusiasm than inexperienced users.

Hypothesis 4. Extended reality previous experience has highly significant differences in attitude to use and perceived usefulness.

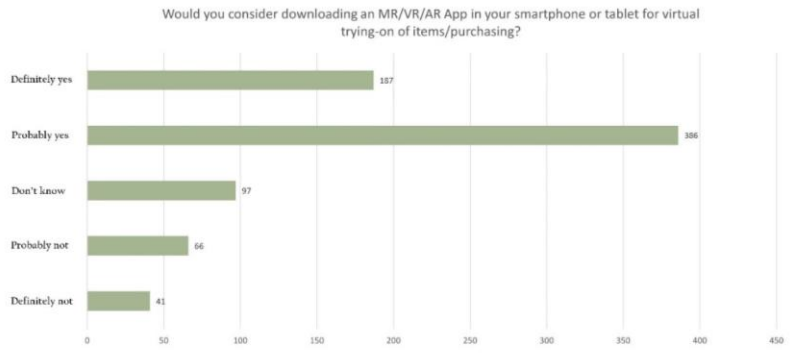

Figure 7. Retail Purchase Apps Perceived Usefulness

Compared to the cost of investing a substantial investment in a personal device, users are more receptive to installing an app.

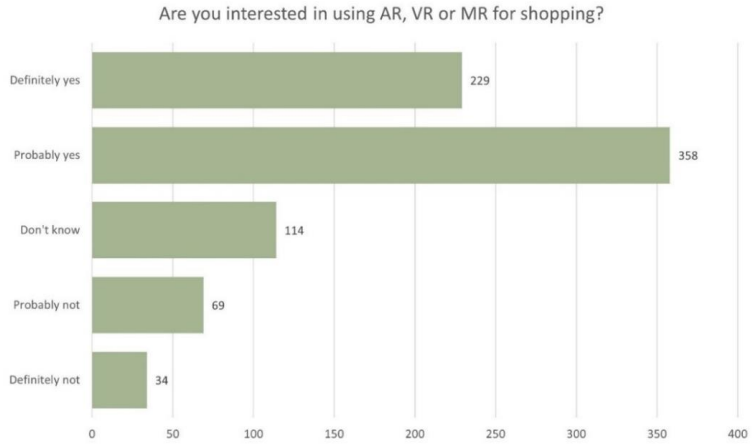

Figure 8. Attitude to Use (WB)

Most participants, 72.7%, presented interest in using extended reality technology for purchasing.

Independent t-test				
	XR Previous Experience (Mean ± Std. Deviation)		*t*	*p*
	Yes (*n*=115)	No (*n*=688)		
Attitude to use	1.78±0.90	2.22±1.08	-4.668	0.000**
Perceived usefulness	1.96±0.83	2.25±1.10	-3.346	0.001**
***p*<0.05 ** *p*<0.01**				

Table 4. XRPE Towards Attitude to Use and Perceived Usefulness Ind. T-test

XR's previous experiences were all highly significant differences in attitude to use and perceived usefulness ($p<0.01$), implying that the different XR's previous experiences were different in attitude to use and perceived usefulness. ($H0 \neq H1$).

Hypothesis 5. Extended reality previous experience has significant associations with AR, VR and None, and has no direct significant associations with MR.

Chi-Square Analysis (N)						
Items	Categories	**XRPE**		Total	X^2	P
		Yes	No			
MR	0.0	60	343	403	0.227	0.633
	1.0	54	340	394		
Total		114	683	797		
AR	0.0	86	577	663	5.71	0.017**
	1.0	28	106	134		
Total		114	683	797		
VR	0.0	65	488	553	9.579	0.002***
	1.0	49	195	244		
Total		114	683	797		
None	0.0	108	596	704	5.296	0.021**
	1.0	6	87	93		
Total		114	683	797		
***, **, * represent 1%, 5%, 10% level of significance respectively						

Table 5. XR Preference and XR Previous Experience Chi-square Analysis

The association between the variables is highly significant in AR and None, and extremely significant associations in VR. It is not statistically significant in MR. (H0≠H1).

VR was selected by 42.98% of users with prior experience of XR and 28.55% of those without prior experience < 30.61% (mean). AR was selected by 24.56% > 16.81% (mean) of those with prior XR experience and 15.52% < 16.81% (mean) of those without prior experience. For those with previous experience with XR, 5.26% chose not to use it again, and 12.74% of those without experience did not prefer any of the XR technologies. Therefore, this means that those with prior XR experience have a higher preference for both VR and AR than those without experience.

In conclusion, this work aims to provide a guideline and perspectives on consumer XR technology acceptance to contribute to extended reality technologies adoption in the retail industry. The survey (n=807) results find out a high degree of acceptance of XR technology among consumers, which emphasises the emerging importance of XR technology. The low public adoption of XR technology (one in ten) demonstrates that a gap exists in the adoption and development of XR technology.

Contributions

This paper extends the study based on Davis' (1989) model of technology acceptance and increases intent to experience, intent to purchase and XR's previous experiences to the model. The conceptual model proposes that intent to purchase, intent to use, intent to experience, attitude to use, perceived usefulness, technology preferences and XR's previous experience impact users' technology acceptance. This study benefits stakeholders and design researchers in consumer and innovative technology retail market research.

Practical implications

Our findings contribute to industry-to-consumer studies on the future development of XR technologies. From a strategic perspective, our findings can guide stakeholders to provide optimal XR technology, user experience and marketing strategies for diverse target customer groups and retail sectors. It also offers evaluative data and actionable insights for the future transition to XR technologies for retail trading businesses.

Research limitations and outlook

Despite some consumers demonstrating a fanatical interest in technology, others are showing a pessimistic attitude. The head-mounted displays of VR and MR limit the availability to consumers who struggle with vertigo or have eye impairment. Further research can focus on cross-culture consumer technology preferences and explore the factors contributing to consumer preferences and awareness differences between Chinese and UK consumers.

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