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Comparing the influence of visual information and the perceived intelligence of voice assistants when shopping for sustainable clothing online

Pei Li [1✉], Chunmao Wu[2✉] & Charles Spence [3]

In an effort to reduce the negative impact of clothing manufacturing on the environment, a number of international clothing brands have made strides towards engaging in more environmentally-sustainable behaviours. However, further research is still needed in order to understand the effects of these efforts on consumer perception and decision-making in the case of sustainable clothing. This study examines the role of visual information (VI) associated with sustainable clothing on a website, and the perceived intelligence of voice assistants (PIVA), in influencing consumers' purchase behaviour (PB) when shopping online for sustainable clothing. 2656 valid samples were collected and analysed using correlation analysis, factor analysis, and regression analysis. The results indicate that VI and PIVA both significantly influence consumers' positive attitudes and PB towards sustainable clothing. Furthermore, the significant effect of these two factors on PB, through positive attitude towards sustainable clothing, are moderated by knowledge of sustainability issues. This paper therefore provides theoretical implications for sustainable clothing online retailing by testing the relationship between relevant variables. The findings also contribute to brand retailers improving their consumers' decision-making and strengthening the perception-behaviour relationship in sustainable clothing shopping.

[1] Department of Fashion Design and Engineering, School of Textiles and Fashion, Shanghai University of Engineering Science, Shanghai, PR China. [2] Department of Product Design, College of Fashion and Design, Donghua University, Shanghai, PR China. [3] Crossmodal Research Laboratory, Department of Experimental Psychology, University of Oxford, Oxford, UK. ✉email: pei.li@sues.edu.cn; cmwu@dhu.edu.cn

Introduction

As greenhouse gas emissions and global warming continue to impact the environment, sustainable consumption has become an increasingly important topic in shopping, with the potential to minimize the negative impact to environment (Kautish and Khare, 2022). Sustainable consumption refers to a type of lifestyle or behaviour that is associated with material recycling and energy conservation (Guillen-Royo, 2019). Several researchers have examined the influential factors when it comes to buying sustainable clothing, including design conception, production chain, product information, knowledge of sustainability issues, consumer attitudes, and purchase behaviour (PB; Henninger et al. 2016; Mukendi et al. 2020; Park et al. 2022; Varshneya et al. 2017).

The main attributes of sustainable clothing are eco-friendliness, that it is ethical, and that it is organic (Goworek et al. 2012). Lee (2011) found that consumers are attracted to eco-friendly, ethical, and organic clothing that is less harmful to the environment and human health and is recyclable after use. However, Gardetti and Torres (2017) note that sustainable product attributes may not necessarily interest consumers when they are purchasing fashion items. During the COVID-19 pandemic, consumers' demand for online shopping and sustainable products increased, thus resulting in an increased frequency of online shopping and greater purchase intent in relation to sustainable items (Kim and Kim, 2022). Group behaviour and peer purchasing attitudes also influence PB in the context of sustainable clothing (Khare and Varshneya, 2017; Varshneya et al. 2017). Sustainable information shared on social media platforms has the potential to attract consumers' attention and promote the latter's PB (Lenne and Vandenbosch, 2017). Consumers with a professional knowledge of sustainable products have more positive attitudes and exhibit a higher purchase intent towards sustainable clothing than those without such knowledge (Okur and Saricam, 2019). However, consumers may not purchase sustainable products if they do not perceive them to be either aesthetic or functional enough (Morgan and Birtwistle, 2009; Rahman and Koszewska, 2020).

Further, consumer experiences and purchasing behaviour can all be enhanced by providing the appropriate (multi-)sensory stimulation (Biswas, 2019; Krishna, 2012; Spence, 2021). Artificial intelligence (AI) technology has been used to create virtual assistants that provide personalised services and contribute to decision-making (Kamoonpuri and Sengar, 2023). AI can also affect purchase intent when it comes to online shopping for sustainable clothing as a result of visual and auditory stimulation (Cornelio et al. 2021). Sensory stimulation in virtual environments directly affects consumers' perception and PB, as can be seen with Amazon and Walmart extending their voice-based shopping to online retailing (Bolton, 2019; McNeil and Moore, 2015; Xi and Hamari, 2021).

Online shopping has the potential to support PB by recommending green product information (Castellacci and Tveito, 2018). Voice assistants can quickly respond to a consumer's questions during online shopping, which may save them time (Moussawi, 2018). Additionally, consumers' hands and eyes are also free to perform other tasks when using voice assistants, thus eliminating the need for typing or the use of a mouse (Luger and Sellen, 2016). Compared with visual screen tools, voice assistants have been shown to recommend products to consumers that encourage consumers' PB (Berriche et al. 2022). Some researchers have even found that a proportion of users consider voice assistants as friends who brought them enjoyment (Rzepka et al. 2020). However, Luo et al. (2019) reported that consumers tend to feel anxious and distrustful of virtual assistants when they are informed that they are interacting with an intelligent bot rather than an actual retailer online.

The aim of the present study is to investigate the effect of multisensory perception on sustainable clothing PB by testing the mediating effects of consumers' attitudes towards sustainable clothing. It takes a multidisciplinary approach to identify those variables enabling AI (i.e., voice assistants) in the context of online shopping and consumption. The purpose of this study is therefore to explore the influence of visual and voice cues on PB, thus contributing to the theoretical studies on multisensory marketing and consumer behaviour. Specifically, the proposal is that multisensory perception positively affects PB. The moderating effects of knowledge of sustainability issues are also explored. Additionally, the results of the present study also identify technology and acceptance issues that online retailers face in developing online services via visual information and voice assistants. The study was conducted online and explored the influential factors regarding sustainable clothing online shopping, and the data was collected in Shanghai, P. R. China. The study is organised as follows: Section "Related work and hypotheses " reviews the literature and related work, such as the perceived intelligence of voice assistants (PIVA) and the attitudes of customers in China towards sustainable clothing. Section "Methods and analysis" outlines the methods used, and the study results are presented in Section "Results". The discussion and implications are presented for online marketing strategy makers and retailers in Section "Discussion and implications". The article concludes with limitations and future research in Section "Limitations and future research".

Related work and hypotheses

AI and multisensory marketing. Brand marketers can adopt AI to help enrich their customers' online shopping experiences, providing various personalised multisensory services. Nowadays, AI involves the use of visual information and voice assistants that can provide personalised services to consumers and thus motivate them to purchase various products. Multisensory marketing has been extended by researchers to new areas to help improve the consumers' perception and shopping experiences (Ho et al. 2013; Spence and Gallace, 2011). With the support of AI, products and services are provided to consumers to enrich their experiences via interface communication and/or voice assistants that can influence their purchase intents (Jain et al. 2022). Researchers have demonstrated that packaging design, symbols, fabric imagery and sounds can all significantly affect the attitudes, emotions, and thereafter the behavioural intentions of consumers (Li et al. 2020, 2022c). Multisensory perception also influences consumers' PB and apparel evaluation (Ho et al. 2013; Krishna et al. 2010; Li et al. 2022b).

Voice assistance has enabled many innovative retail brands to offer unique experiences to their consumers (e.g., see Jackson, 2020; Kautish et al. 2023). In particular, chatbot voice assistants have been found to meet a number of the consumers' online requirements (Beauloye, 2022). When it comes to online shopping for luxury brands, the relationship between AI-powered digital assistance and consumer engagement is likely to be moderated by multisensory cues (Rahman et al. 2023). Virtual reality and augmented reality in online shopping assist retailers in realizing multisensory marketing strategies to help meet consumers' needs in a way that is personalised (Jin and Youn, 2022). Without the assistance of technology, it becomes more challenging for retailers to respond to respond quickly to the consumers' requirements, or there might be some risks associated with decision-making in online shopping (e.g., insufficient information concerning the product, problems about delivery time).

However, some researchers find that consumers may not feel altogether comfortable when engaging in shopping online via digital assistance. For example, Castillo et al. (2021) conducted in-depth interviews with 27 customers who communicated with AI chatbots, and identified two problematic aspects in the interaction (namely affective issues, cognitive issues). Congruency, such as perceived natural speech and human-likeness, are two vital dimensions as far as voice assistants are concerned (Hu et al. 2023). In the context of voice marketing, incongruent conversations with voice assistants may reduce consumer trust and lower their willingness to buy the recommended products when shopping online (Hu et al. 2023). Thus, observing consumers' PB in the case of sustainable clothing, which may be greatly affected by voice assistance, is vital when it comes to the development of more effective brand marketing strategies (Prentice and Nguyen, 2020).

The role of attitudes towards sustainable clothing in PB. Attitude refers an individual's evaluation of things; a psychological state of favoritism and preference for a product that leads to judgments (i.e., positive or negative) and emotional reactions (Shepherd, 1992). Consumers' positive attitudes have been shown to exert a great impact on purchase intention, indicating that attitude is the main factor determining sustainable consumption (Park et al. 2022; Peattie, 2010; Rausch and Kopplin, 2021). Previous studies have established that the consumers' positive attitude towards sustainable clothing significantly influences their purchase intentions as well as their PB (Jacobs et al. 2018; Okur and Saricam, 2019; Varshneya et al. 2017).

Han (2017) collected 784 samples from Chinese university students and used structural equation modelling to explore their intentions when it came to buying sustainable clothing, finding that an individual's attitudes towards buying sustainable clothing was the key predictor of PB. Furthermore, the attitude towards sustainable clothing was found to be influenced by consumers' knowledge of environmental apparel (Chang and Watchravesringkan, 2018). In the United States, a study by Varshneya et al. (2017) demonstrated that consumers' positive attitudes towards sustainable clothing are important factors as far as their willingness to pay a premium is concerned. Thus, consumers' positive attitudes are an important factor when shopping for sustainable clothing (Jacobs et al. 2018).

When it comes to the purchase of sustainable clothing, consumers have certain demands on sustainability because they may be aware of certain environmental issues that generate purchase motivation and thus may lead to PB (Hasbullah et al. 2022; Varshneya et al. 2017). Some researchers have found that there is a gap between consumers' attitudes and their PB in the case of sustainable clothing retailing (Young et al. 2009). There are some barriers in sustainable clothing retailing, such as limited knowledge of customers, and unattractive visual information about clothing (Harris et al. 2016; Hiller Connell, 2010). Previously, the relationship between attitude and behaviour was identified with the theory of reasoned action and the theory of planned behaviour (Ajzen, 1991; Ajzen and Fishbein, 1980). That is, consumer behaviour can be predicted by positive attitude (Abeysekera et al. 2022). However, it turns out that there is often a gap between the consumers' attitudes and their purchase intentions, and not all consumers will necessarily transfer their attitude into an increased likelihood of purchasing sustainable clothing (Young et al. 2009). In the purchasing of sustainable clothing, there is a gap between positive attitude and behaviour can be affected by the higher cost of sustainable products than conventional ones (e.g., Moser, 2016). Thus, it is hypothesised that:

H1. Customers' positive attitude towards sustainable clothing has a positive impact on PB.

Visual information. Visual stimulation is undoubtedly a crucial factor influencing the consumers' purchase intention and behaviour (Bhatia et al. 2022). The majority of the information we perceive is visual (Gallace et al. 2012; Hutmacher, 2019), and this is as likely to be true in the context of online shopping as anywhere else. Visual cues have been considered as an important factor influencing customers' PB (Huddleston et al. 2023; Lin and Chen, 2006). Product intrinsic cues related to product quality attributes may influence the assessment of consumers (Szybillo and Jacoby, 1974). Extrinsic cues include retail signage, price, brand name, country of origin and websites that may affect visual attention and selection (Ladeira et al. 2019). When individuals browse the internet, they perceive clothing intrinsic attributes, such as patterns, styles, colours, and fabrics, through images and/or textual information. Visual information can trigger the consumer's imagination (i.e., visual, and other forms of, mental imagery) about the clothing, even if they have not actually seen it directly (i.e., in person).

When shopping online, recommended information, including fabrics, styles, colours, decorations and patterns, can all influence the consumers' decision-making (Mathwick et al. 2001). For example, when individuals see the colour blue on the screen of their laptop, they may easily envision the sky or sea; a red colour may evoke feelings of heat or warmth (see Spence, 2020). Consumers tend to have a positive attitude towards products displayed online when they are attracted by visual information, such as symbolic imagery (Gefen and Straub, 2000; Rahman and Koszewska, 2020; Yong et al. 2010; see also McNorgan, 2012, for a summary of the neural substrates of mental imagery in different sensory modalities).

Social media also influences the consumers' perception of sustainable clothing and purchasing behaviour when shopping online (Kautish and Khare, 2022). Both pictorial and verbal information (e.g., text, images, videos) can significantly affect consumer emotions and behaviour (Li et al. 2022a; Magrath and McCormick, 2012; Okonkwo, 2007; White et al. 1978). Wang et al. (2021), who collected 504 valid samples through the Questionnaire Star Platform, demonstrated that visual complexity of the interface and visual search efficiency affected consumers' intention to buy the products on online shopping. Meanwhile, some researchers found that visualization in online shopping has a relationship with haptic/tactile mental imagery (Silva et al. 2021; Spence, 2023; Zhang et al. 2004). For example, consumers can imagine the comfort of the fabric via visual stimulation, such as by seeing the softness of mohair. Recommended clothing information can have a significant impact on consumers' decision-making (Baier et al. 2020).

Sustainability information is communicated to consumers in two forms: verified sustainability labels, and unregulated communications (Turunen and Halme, 2021). Sustainability information pertains mainly to product sustainability, lifecycle, and the use of organic materials (Bratt et al. 2011; Claudia, 2015). The sustainability of clothing is related to the lifecycle of the apparel, as well as its durability, and whether it is made from recycled and biodegradable materials (Lundblad and Davies, 2016; Scherer et al. 2018). Some fashion brands, such as Decathlon and Weecos, provide sustainable clothing online so as to enhance the customers' attitude and PB (Weecos, 2020). Thus, it is hypothesised that:

H2. Visual information has a positive impact on customers' positive attitude towards sustainable clothing.

H3. Visual information has a positive impact on PB.

Perceived intelligence of voice assistants. With the development of AI, voice assistants are becoming increasingly prevalent in online retailing (Hasan et al. 2021). Voice-based shopping refers to a vocal interaction between consumers and voice assistants that qualifies and personalises services in the shopping process (Vachaudez and Geerts, 2020). Voice assistants provide information to consumers in an increasingly human-like manner to motivate their engagement based on users' preferences and personal information (McLean et al. 2021). AI is used to improve the experience of consumers when seeking product-related information, ordering items online, and purchasing products (Aw et al. 2022; Canziani and MacSween, 2021; Jain et al. 2022). Moreover, speech recognition systems are now being adopted by companies (e.g., Alibaba, Amazon Alexa, Apple Siri, Google) in order to communicate more efficiently with their consumers (Maroufkhani et al. 2022). The daily needs of consumers can be collected and captured by voice assistants that perform tasks based on consumers' preferences (Lucia-Palacios and Pérez-López, 2021). For example, voice assistants make technical services much easier for elderly consumers than text-based interactions, which lowers the barrier between brands and their consumers (Chattaraman et al. 2019).

Consumer-to-machine interactions may stimulate consumers' perception, cognition and behaviour in a dynamic shopping process (Marinova et al. 2017). Many consumers have already adopted voice assistants in order to order food, send messages, listen to music, and much more (Poushneh, 2021). Consumers benefit from the intelligent attributes of voice assistants. First, voice assistants are interactive, and may enable consumers to express their needs more directly/intuitively (Pitardi and Marriott, 2021). Second, voice assistants are knowledgeable and respond efficiently to the needs of consumers and/or recommend product information to them (Kang and Shao, 2023). However, there are limitations to the acceptance of AI. For example, AI relies on algorithms which may not refer to customers' cognition, emotions and intentions (Malodia et al. 2022). Further research is therefore needed in order to explore how consumers operate voice assistants to enhance their positive attitudes and emotions (Choi and Drumwright, 2021; Kinsella & Mutchler, 2019).

More research is also needed in order to explore how voice assistants affect consumer decision-making (Van Doorn et al. 2017). Voice assistants can be used to enhance consumers' perception of the product and to encourage positive attitudes and PB towards products (Al-Fraihat et al. 2023; Poushneh, 2021). Berriche et al. (2022) conducted a qualitative study using semi-structured interviews and found that consumers' judgements and attitudes were affected by the speed of responses and the capacity of voice assistants to provide responses that were personalised. Voice assistants motivate consumers' positive attitudes and influence them to use the AI technology and also shape their intention to continue using it (Choi and Drumwright, 2021). Consumers' positive emotions may also be enhanced as a result of communicating effectively with voice assistants (Poushneh, 2021). The usefulness of voice assistants significantly affects consumers' willingness to use mobile devices in the context of online shopping (Canziani and MacSween, 2021). Meanwhile, some researchers suggest that the negative perception of voice assistants influences consumers' assessment of products, brand credibility and privacy risk (Dellaert et al. 2020; Jain et al. 2022). Thus, we hypothesis that:

H4. Perceived intelligence of voice assistants has a positive impact on customers' positive attitude towards sustainable clothing.

H5. Perceived intelligence of voice assistants has a positive impact on sustainable clothing PB.

Knowledge about sustainability issues. Knowledge about sustainability is related to environmental knowledge that refers to the impact of human activities on the environment (Arcury and Johnson, 1987). Kim and Damhorst (1998) first examined environmental knowledge in the context of consumers' environmental behaviour, arguing that consumers would tend to pay attention to environmental issues and engage in environmentally-friendly consumption behaviours. Knowledge is supported by consumers' information on product production, usage, and consumption in relation to the environment (Zhang and Lang, 2018). Knowledge about sustainable issues correlates with consumers' intention to buy clothing (Han, 2017; Okur and Saricam, 2019). After exploring college students' psychology as it relates to retail shopping, researchers demonstrated that students with a high knowledge concerning environment protection are more likely to buy sustainable clothing (Brandão and Costa, 2021). Thus, companies should pay attention to producing recycled and upcycled clothing, a trend that has already been accepted by many consumers, according to the study from Friedrich (2021) that was carried out on 500 German consumers to discover their preferences for sustainable clothing.

Those consumers having some knowledge of sustainability issues might not necessarily make a purchase because they do not have sufficient knowledge about clothing product (Connell, 2010). Various factors, such as cost, lack of knowledge about sustainability and convenience, may all influence consumers' decision-making in the context of online retailing (Francis and Davis, 2015). To solve the problem in terms of their decision-making, consumers need relevant knowledge about sustainability to help them select and buy products (Williams and Hodges, 2022). At present, the popularity of sustainable clothing isn't particularly high and information concerning sustainable clothing is typically not recommended efficiently by retailers, which is also the main reason that lowers the consumers' purchase intention (Su et al. 2018).

Han (2017) found a significant relationship between consumers' product knowledge and PB when shopping for organic cotton clothing. When consumers have more knowledge and experiences about sustainable clothing, they tend to have more positive attitudes that contribute to their purchase intents (Kautish and Khare, 2022; Sun et al. 2018; Yadav and Pathak, 2016). Knowledge of sustainability issues can benefit consumers, brand managers, marketers and those researchers who are interested in exploring the role of AI technology in clothes shopping (Kautish et al. 2019). Additionally, the desire for information about sustainability hints at a growing public concern for environmental issues (Thorisdottir and Johannsdottir, 2020). Thus, the following hypothesis is proposed:

H6. The effect of perceived visual information on PB, through customers' positive attitude towards sustainable clothing will be moderated by their knowledge concerning sustainability issues.

H7. The effect of perceived intelligence of voice assistants on PB, through the customers' positive attitude towards sustainable clothing will be moderated by the customers' knowledge about sustainability issues.

The model is based on the perspective that sensory perception (visual information, perceived intelligence of voice assistants) might influence sustainable clothing PB in the context of online shopping (see Fig. 1). Furthermore, it is suggested that the customers' positive attitude towards sustainable clothing will tend to mediate the relationship between sensory perception and PB. The effect of customers' knowledge about sustainability issues is evaluated as a moderator in the model.

Methods and analysis
Data collection. Data was collected on the star platform by onsite filling the questionnaire (https://www.sojump.com), which has
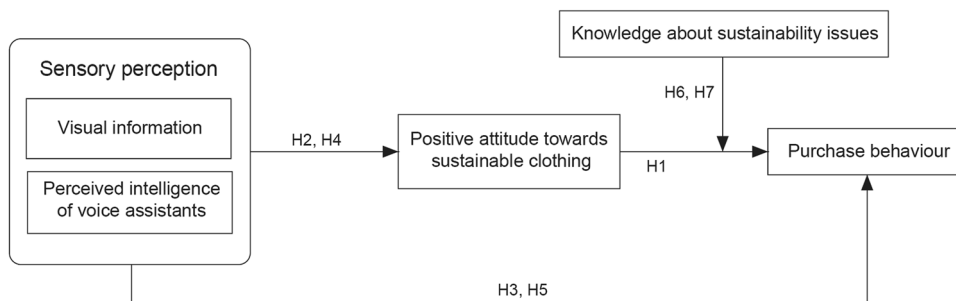
Fig. 1 A conceptual model of sensory perception and PB in online shopping. Visual information, perceived intelligence of voice assistants, positive attitude towards sustainable clothing, knowledge about sustainability issues, purchase behaviour.

Table 1 Demographic characteristics of participants.

Variable	Characteristics	Frequency	Percentage
Sex	Female	1426	53.7%
	Male	1230	46.3%
Age (Years)	Under 18	420	15.8%
	18–23	908	34.2%
	24–29	616	23.2%
	30–35	444	16.7%
	36–41	212	8.0%
	Above 41	56	2.1%
Education	High school and below degree	493	18.6%
	Associate degree	958	36.1%
	Bachelor degree	1018	38.3%
	Master and PhD degree	187	7.0%
Occupation	Government-sponsored institution	760	28.6%
	Private sector	743	28.0%
	State-owned sector	506	19.1%
	Self-employed sector	506	19.1%
	Student	127	4.8%
	Others	14	0.5%
Monthly spend on clothing	499 Chinese yuan and below	730	27.5%
	500–999 Chinese yuan	697	26.2%
	1000–1499 Chinese yuan	536	20.2%
	1500–1999 Chinese yuan	379	14.3%
	2000–2499 Chinese yuan	294	11.1%
	2500–2999 Chinese yuan	7	0.3%
	Over 3000 Chinese yuan	13	0.5%

similar functions to Surveymonkey or MTurk. The participants were invited to the platform, and those who completed the questionnaires online were entered into a lucky draw. The prizes consisted of (a) 8.8 Chinese yuan of wechat red packet; (b) 5.5 Chinese yuan of wechat red packet; (c) six bottles of yogurt; or (d) thanks for joining. To focus on the purpose of this study, the participants were asked to recall their online shopping experiences (e.g., visual information, voice interaction) before answering the questionnaires.

According to the findings of Meade and Craig (2012), if a participant's mean response time is three times more than that of the rest of the sample then it is likely to be invalid. After deleting invalid samples, a total of 2656 valid questionnaires were included in the final analysis. Of the 2656 participants, the majority were women ($n = 1426$, 53.7%), while, 2163 participants had completed higher education (e.g., bachelor's degree, $n = 1018$, 38.3%; see Table 1 for the demographic characteristics of participants).

Measurement of constructs. To test the relationship between variables, items were adopted or revised from previous studies. Items were rated on a five-point Likert scale with ratings ranging from "1 = strongly disagree" to "5 = strongly agree". The three items concerning visual information (VI) were revised from Baier et al. (2020), D'Souza et al. (2007), and Fulton and Lee (2013); The five items related to the perceived intelligence of voice assistants (PIVA) were adopted from Bartneck et al. (2009); The four items concerning customer's knowledge about sustainable issues (KSI) were adopted from Kamalanon et al. (2022); The four items concerning the customers' positive attitude towards sustainable clothing (ATSC) were revised from Butler and Francis (1997), Chan (2001), Park and Lin (2018), and Wu and Chen (2014); The three purchase behaviour (PB) items were revised from Lee (2008), Nguyen et al. (2018), and Schlegelmilch et al. (1996). Data on VI, PIVA, KSI, ATSC and PB was collected prior to the demographic information.

Analysis. To test the congruence of the hypothesis, the valid data were analysed in the following steps. Data analysis was performed by using SPSS Statistic 23.0 software and Amos 23.0. First, the Cronbach's Alpha values and factor loading were calculated, and the threshold value of Cronbach's Alpha is greater than 0.60 was considered as acceptable (Nunnally and Bernstein, 1994). The composite reliability (CR), average variance extracted (AVE), and (KMO) were calculated. The threshold value of CR, AVE and KMO are greater than 0.70, 0.50, and 0.70, irrespectively (Fornell and Larcker, 1981). Thus, the reliability and validity are assessed. Furthermore, multiple regression analysis was operated to assess the relationship between variables. The threshold value of VIF are smaller than 5, that revealed no multicollinearity in the regression models (Hair et al. 1998). Third, the process mediating test was adopted on data analysis. Fourth, the moderating effect was tested. Supported by previous finding from Charlton et al. (2021), the valid confidence intervals did not overlap zero.

Results

Reliability and validity. All values of Cronbach's alpha exceeded 0.8, demonstrating that the convergent validity of the variables is above the threshold (Hair et al., 2010). The factor loadings of all items were above 0.5 (see Table 2), indicating convergent validity (Fornell and Larcker, 1981). Confirmatory factor analysis revealed that the model had a good fit ($X^2/df = 2.914$, GFI = 0.992, AGFI = 0.983, CFI = 0.995, IFI = 0.995, NFI = 0.993, RMSEA = 0.027) (Anderson and Gerbing, 1988). Finally, the average variance extracted (AVE) value for the variables was above the threshold of 0.5 (Fornell and Larcker, 1981). Table 3

Table 2 Reliability and validity test.

Construct	Item	Factor loading (>0.5)	Cronbach's alpha (>0.7)
Visual information	VI1: Use of bio-based recyclable materials or fibres.	0.747	0.837
	VI2: Product longevity in terms of robustness, reparability and timelessness.	0.767	
	VI3: Product's sustainability guaranteed with a label.	0.792	
Perceived intelligence of voice assistants	PIVA1: Voice assistant appears competent.	0.786	0.868
	PIVA2: Voice assistant is knowledgeable.	0.829	
	PIVA3: Voice assistant provides relevant information.	0.791	
	PIVA4: Voice assistant is intelligent.	0.722	
	PIVA5: Voice assistant provides accurate information.	0.616	
Customer's knowledge about sustainability issues	KSI1: I know how to behave sustainably.	0.777	0.884
	KSI2: I know how to lower ecological harm with my behaviour.	0.846	
	KSI3: I understand how to reduce the negative environmental consequences of my behaviour.	0.847	
	KSI4: I understand how to protect the environment in the long-term.	0.762	
Customers' positive attitude towards sustainable clothing	ATSC1: I think buying sustainable clothing is a very wise choice.	0.773	0.866
	ATSC2: I think that wearing sustainable clothing is conducive to improving people's awareness of environmental issues.	0.825	
	ATSC3: I think buying sustainable clothes is beneficial to protecting the environment (ecology).	0.820	
	ATSC4: I think that sustainable clothing has great development potential.	0.697	
Purchase behaviour	PB1: I purchase sustainable clothes even if they are more expensive than conventional clothes.	0.858	0.879
	PB2: When buying clothes, I pay attention to their sustainability credentials.	0.810	
	PB3: I am willing to pay more for clothing that is sustainable or that helps protect the environment.	0.808	

VI visual information, *PIVA* perceived intelligence of voice assistants, *ATSC* customers' positive attitude towards sustainable clothing, *KSI* customer's knowledge about sustainability issues, *PB* purchase behaviour.

Table 3 Property and correlation matrix highlighting significant terms.

Variable	AVE	KMO	CR	VI	PIVA	ATSC	KSI	PB
VI	0.591	0.723	0.813	1				
PIVA	0.566	0.846	0.866	0.547**	1			
ATSC	0.609	0.821	0.861	0.460**	0.426**	1		
KSI	0.654	0.833	0.883	0.493**	0.470**	0.460**	1	
PB	0.682	0.740	0.865	0.510**	0.455**	0.463**	0.410**	1

AVE means average variance extracted; CR means composite reliability.
** indicates $p < 0.01$.

Table 4 The results of multiple regression.

Hypothe-sis	Relationships	β	T	B (95% CI)	VIF	p-value	F	R-square
H1	ATSC → PB	0.230	12.197	(0.228, 0.316)	1.433	0.000	457.234	0.340
H3	VI → PB	0.295	14.862	(0.286, 0.373)	1.586	0.000		
H5	PIVA → PB	0.185	9.413	(0.174, 0.265)	1.548	0.000		
H2	VI → ATSC	0.334	17.234	(0.280, 0.352)	1.427	0.000	574.254	0.302
H4	PIVA → ATSC	0.291	15.005	(0.254, 0.331)	1.427	0.000		

presents the correlation of the variables and the values of KMO and CR.

The outcome of VI, PIVA, and ATSC. In the first step, multiple regression analysis was conducted to examine the impact of ATSC and PB. The results indicate a significant relationship exists between ATSC and PB ($\beta = 0.230$, $t = 12.197$, $p < 0.001$), thus supporting H1. Next, the relationship between VI and ATSC was investigated. The results revealed a positive relationship between VI and ATSC ($\beta = 0.334$, $t = 17.234$, $p < 0.001$), suggesting that consumers' perception of visual information has a significant effect on their positive attitudes towards sustainable clothing, thereby supporting H2. Moreover, the analysis indicates that the more consumers perceive information to be useful, the more likely they are to purchase sustainable clothing ($\beta = 0.295$, $t = 14.862$, $p < 0.001$), thus supporting H3.

In the final step, the relationship between PIVA, ATSC, and PB was tested. The analysis revealed a positive effect of PIVA on both ATSC ($\beta = 0.291$, $t = 15.005$, $p < 0.001$) and PB ($\beta = 0.185$, $t = 9.413$, $p < 0.001$), thus supporting H4 and H5, respectively. Table 4 presents the results of the multiple regression analysis.

The mediating effect of ATSC. Process SPSS was adopted to test the mediating effect. The valid confidence intervals were valid when the value was above zero or below zero (Hayes, 2013). The results proved that ATSC had a mediating effect between VI and PB ($t = 15.126$, $p < 0.001$). ATSC also had a mediating effect between PIVA and PB ($t = 17.159$, $p < 0.001$). Table 5 and Table 6 show the influence of mediate effects of ATSC.

The moderating effect of SK. There was a positive relationship between VI and PB, moderated by KSI (LLCI = −0.087, ULCI = −0.018, $p < 0.001$). This finding suggests that those consumers having a greater knowledge of sustainable clothing are more likely to have a positive attitude and behaviour towards sustainable clothing during the shopping process than those without such knowledge. Moreover, the results revealed that KSI is a significant factor between VI and PB, such that a higher KSI would appear to strengthen the relationship between ATSC and PB (LLCI = −0.103, ULCI = −0.033, $p < 0.001$), thus supporting H6.

Furthermore, the relationship between PIVA and PB was also moderated by KSI (LLCI = −0.103, ULCI = −0.033, $p < 0.001$). This finding indicates that PB is affected by PIVA and ATSC, and moderated by KSI, thereby supporting H7. Table 7 presents the results relating to H6 and H7.

The final step of the data analysis formalises both the moderator and mediator effects of H6 and H7. The magnitude of the conditional indirect effects (via the mediator of ATSC) of the independent variable (VI) on the dependent variable (PB) at different levels of the moderator (KSI) was calculated. Table 8 presents the indirect effect of three values of KSI: one standard deviation below the mean (−1), the mean, and one standard deviation above the mean (+1). In Table 6, the results indicate a significant indirect effect (mediated by ATSC) between VI and PB with three levels of KSI (+1 SD: LLCI = 0.167, ULCI = 0.278; −1 SD: LLCI = 0.267, ULCI = 0.373). Furthermore, the results reveal that the indirect effect (VI → ATSC → PB) is stronger when the KSI increases. This finding indicates that the positive effect of VI on PB through ATSK is enhanced when consumers perceive more SK than those who have limited knowledge about

sustainability, thus also supporting H6. As the indirect effect (PIVA → ATSC → PB) is significant (+1 SD: LLCI = 0.180, ULCI = 0.294; −1SD: LLCI = 0.309, ULCI = 0.416), H7 is also supported.

Discussion and implications

With the development of AI and sustainable clothing retailing, there has been a growth in the exploration of consumer perception that may facilitate multisensory shopping experiences (e.g., Bhatia et al. 2022; Gallace et al. 2012; Ho et al. 2013; Krishna, 2012; Li et al. 2022b, 2022c; Rahman et al. 2023; Yoganathan et al. 2019). In recent years, AI technology has been adopted to enhance the customer's experience of online shopping (Ameen et al. 2022). Specifically, some scholars uphold the idea that voice assistants enrich consumers' online shopping experiences and may result in the latter spending more on clothing (Kim and Forsythe, 2008; Petit et al. 2019). Despite the benefits of AI technology in the context of online retail, limited findings concerning voice assistants are specifically associated with PB in the context of clothing retail (Kang and Shao, 2023). The understanding of sustainable clothing purchasing behaviour with the support of AI technology and its application in marketing is needed to encourage customer perception and is useful in chatbot applications (Luo et al. 2019). Supporting this point, the present study proposes a conceptual model to explore visual information and the perceived intelligence of voice assistants when customers shop for sustainable clothing. Sensory perception, positive attitude towards sustainable clothing, and sustainable knowledge help their effects on PB in the context of online clothing retail to be explored. The study reported here provides empirical evidence that visual information regarding sustainable clothing and perceived intelligence of voice assistants improve consumers' experiences when purchasing sustainable clothing online via multisensory interaction. Specifically, perceived convenience of voice assistants can trigger consumers' trust in online shopping (Malodia et al. 2023).

First, we found that having a positive attitude towards sustainable clothing positively affects PB, consistent with previous literature (Rausch and Kopplin, 2021). As hypothesised, positive attitudes appear to influence PB in relation to sustainable clothing. Some customers are even willing to pay more for sustainable products than for non-sustainable ones so as to help protect the environment. These findings indicate that environmental protection policies and sustainable clothing brands can actively promote the concept of sustainability both online and offline to influence people's opinions and positive attitude towards sustainable clothing. Multisensory interaction is effective in engaging consumers when they purchase sustainable products online, specially, supported by AI technology. This also helps to explain why it is that advanced technology may facilitate consumer involvement and motivate them to spend more time shopping online than ever before.

Table 5 The results of direct effects.

Direct effects	Beta	T	P value
VI → PB	0.510	30.536	0.000
PIVA → PB	0.453	26.210	0.000
ATSC → PB	0.462	26.827	0.000

Table 6 The results of the mediating effect.

Construct		T-value	Effect	BootSE	BootLLCI	BootULCI	Decision
VI → ATSC → PB	Direct	20.261[***]	0.373	0.018	0.337	0.409	Full mediation
	Mediation	15.126[***]	0.137	0.012	0.114	0.160	
	Total	30.536[***]	0.510	0.017	0.477	0.543	
PIVA → ATSC → PB	Direct	16.305[***]	0.303	0.019	0.267	0.340	Full mediation
	Mediation	17.159[***]	0.150	0.013	0.127	0.176	
	Total	26.210[***]	0.453	0.017	0.420	0.487	

Note: ***$p < 0.001$.

Table 7 Hypothesised relationship between H6 and H7 (mediator—customer's knowledge about sustainability issues; moderator —customers' positive attitude towards sustainable clothing).

Hypothesis	Variable	Coeffect	t	SE	LLCI	ULCI	F	R²
H6	VI	0.358	16.780***	0.021	0.316	0.400	338.630	0.338
		0.174	8.284***	0.021	0.133	0.215		
		−0.053	−3.003***	0.018	−0.087	−0.018		
H7	PIVA	0.302	13.388***	0.023	0.255	0.346	303.739	0.314
		0.205	9.695***	0.021	0.163	0.246		
		−0.068	−3.814***	0.018	−0.103	−0.033		

***$p < 0.001$.

Table 8 Hypothesised relationship (mediator—customer's knowledge about sustainability issues; moderator—customers' positive attitude towards sustainable clothing).

Hypothesis	Variable	Value of customer participation	Effect	SE	LLCI	ULCI
H6	VI	−1SD (3.094)	0.320	0.027	0.267	0.373
		M (3.534)	0.271	0.023	0.227	0.316
		+1SD (3.890)	0.223	0.028	0.167	0.278
H7	PIVA	−1SD (3.034)	0.362	0.027	0.309	0.416
		M (3.540)	0.300	0.023	0.255	0.345
		+1SD (3.936)	0.237	0.029	0.180	0.294

Second, based on the findings reported here, visual perception can have a positive influence on people's positive attitude towards sustainable clothing, in line with previous findings (Lenne and Vandenbosch, 2017). This study not only in line with the results of previous research (Rahman and Koszewska, 2020; Yoganathan et al. 2019), but also confirms the contribution made by visual information to the purchasing of sustainable clothing. Specifically, information concerning materials, product longevity and clothing labels was found to influence people's positive attitudes. Clothing designers should also use organic materials and label it in clothing information to help attract the attention of consumers.

Third, we identified that improving the visual information that is presented is essential when it comes to encouraging consumers to buy sustainable clothing. This finding demonstrates that visual product presentation and information attract the attention of consumers when buying clothing online (Rossolov et al. 2021). Furthermore, it indicates that high-quality visual information benefits consumers' positive attitudes and PB as far as stimulating the consumers' experience is concerned (Mo et al. 2022). If the images are too small, or the information is insufficient, it may lead to a less satisfactory shopping experience. Therefore, technology companies should focus on consumers' perception of visual information and consider the features of sustainable clothing, such as aesthetics and vividness, in order to stimulate consumer decision-making in the context of online shopping.

Fourth, the results of the present study reveal that voice assistants play an important role in online shopping for sustainable clothing. The findings reported here show that consumers' positive attitude towards sustainable clothing are affected by the perceived intelligence of voice assistants, emphasising the driver for consumer perception, consistent with the findings of previous research (Aw et al. 2022; Kang and Shao, 2023; Poushneh, 2021). Voice assistants foster positive attitudes in online shopping, indicating that digital technology can provide qualified services to consumers who can make purchase decisions with the support of intelligent functions. Voice assistants based on AI technologies power the online shopping context by providing personalised services that promote certain attitudes in attitudes and behaviours in consumers when they purchase sustainable clothing. Hence, retailers are encouraged to explore the application of AI technology, such as voice assistants, so as to affect the customers' motivation and enhance their attitude.

The significant impact of the perceived intelligence of voice assistants on consumers' positive attitude towards sustainable clothing implies that brand operators and marketers should explore more potential functions and humanising services (Poushneh, 2021). One way to achieve this is to enrich knowledge and product information about sustainability in the database. Having sufficient knowledge of sustainability can be effective in supporting consumer decision-making. For those retailers who wish to adopt AI in online services, identifying consumers' perceptions and promoting their engagement in online shopping is helpful. Clothing brands should therefore encourage consumers to engage with personalised voice assistants, and technology companies should consider developing more autonomous voice assistants that can respond to consumers' requirements efficiently. Especially during the online interaction between customers and AI technology, creative ideas may be generated (Madjar, 2008).

Fifth, the perceived intelligence of voice assistants was found to be associated with the role of sustainable clothing retailing in the context of online shopping, highlighting that consumers' PB is stimulated by their perception of voice assistants. This finding is consistent with previous findings showing that when consumers interact with voice assistants, they may be encouraged to learn more about the product and this encourages consumers towards purchasing it (Poushneh, 2021). This can be attributed to the fact that the experience of online shopping is enriched by the perceived intelligence of voice assistants, supported by AI (Petit et al. 2019). This means that those people having a better impression of voice assistants will also have a more positive attitude towards them, and consequently be more likely to purchase sustainable clothing. The present study provides a number of implications for clothing brand managers, retailers, and voice assistant developers. In particular, voice assistants can enhance consumers' intention to purchase when shopping online. Thus, retailers need to consider how to engage more consumers in online shopping via offering beneficial information and a timely response.

Sixth, the findings reported here demonstrate a significant effect (mediated by ATSC) between visual information and PB

with the mediating effect of knowledge about sustainability issues in the relationship of VI → ATSC → PB. This finding is in line with previous research from Mehta et al. (2022), showing that sustainable clothing purchase attitudes moderate the relationship between consumers' purchase intention and their behaviour in the context of fast fashion. This finding is attributed to the importance of knowledge concerning sustainability, which indicates that if people have a positive attitude towards buying sustainable clothing, they tend to purchase the product. When consumers have sufficient visual information and knowledge about sustainability, they tend to have a positive attitude and exhibit a higher intention to purchase. Thus, it makes sense for brand managers and online retailers to develop useful visual information and add sustainability information online (e.g., text, images) to support the consumers' decision-making.

Finally, a significant effect of the moderator of customer's knowledge about sustainability issues was identified on the relationship between ATSK and PB in the relationship of PIVA → ATSC → PB. This shows us how to affect consumers' PB through consumers' perceived intelligence of voice assistants, changing their attitude towards decision-making during sustainable clothing shopping (Su et al. 2019). This may be caused by the perceived intelligence of voice assistants, which can recommend sustainable clothing information directly to the consumer. Consumers can initiate online communication with voice assistants to solve multiple problems and bridge the gap of knowledge acceptance and purchase intent. The perceived intelligence of voice assistants encourages consumers to engage in online shopping that can provide quick and efficient feedback. Thus, brand managers and and voice assistant developers should recognise consumers' needs, and emphasise knowledge about sustainability in order to improve consumers' perception and PB. Specifically, it is vital to provide a stimulation on multisensory perception for consumers when communicating with voice assistants online.

As retailers play an important role in helping to promote sustainable clothing shopping online (Jones et al. 2014), they can make some managerial contributions. This study suggests that fashion companies and retailers should explore the perception of sustainable clothing with the development of technology (e.g., voice assistant) and associate it with knowledge concerning sustainability for consumers. The results reported here also provide guidelines for those brand managers wishing to bridge the gap between sensory marketing strategies for selling sustainable clothing and consumers' perceptions of online shopping.

Limitations and future research

This study has a number of limitations that need to be acknowledged. First, the research was conducted in China, which obviously limits its generalisability to other parts of the world, particularly those in Europe. The sample collected may not be representative of the perceptions of sustainable clothing in European countries, which obviously have their own local cultures and traditions. Future studies should therefore consider exploring the relationship between variables in European countries and conducting the relevant cross-cultural comparisons. Second, this study was limited to exploring visual information relating to sustainable clothing and the perceived intelligence of voice assistants. However, with the development of AI, other sensory stimuli may be involved in online shopping (e.g., enhancing the haptic softness of fabric via music softness-association; see Spence, 2022, for a review). Future studies can confirm variables in multisensory experiences that encourage consumers to engage in the purchasing of sustainable clothing online. Finally, the effect of gender was not tested in this study, and the majority of the

participants were under 41 years of age. Future studies should therefore consider focusing on testing groups of different sexes/genders and/or different age groups.

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Author contributions
PL contributed to the design of the study; PL and CW contributed to the data collection and performed the data analysis; PL wrote the first draft of the manuscript; PL and CS contributed to the manuscript revision, as well as reading and approving the submitted version.

Competing interests
The authors declare no competing interests.

Ethical approval
Approval was obtained from the ethics committee of the Shanghai University of Engineering Science (Ethics approval number: EST2023019). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Informed consent
Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements. There was an online informed consent for participation, who were informed that: (a) the collected data were contributed to academic research rather than any commercial activities; (b) the personal information would not be published. If the participants wished to consent to the instruction, they clicked 'agree and continue' button. They were then able to fill-in the questionnaires.

Additional information
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Correspondence and requests for materials should be addressed to Pei Li or Chunmao Wu.

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