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Augmented Reality in Retail: A Systematic Review of Research Foci and Future Research Agenda

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Abstract

Purpose: This paper synthesises peer-reviewed published journal articles on augmented reality in retail settings to ascertain the current foci of academic research in this nascent area and develop a conceptual framework to form the basis for a future research agenda.

Design/methodology/approach: Thematic analysis was conducted on a sample of 76 papers published between 1997-2020 identified through a systematic search of high quality peer-reviewed papers.

Findings: Three major research avenues and theoretical bases emerged: AR adoption-based factors with technology acceptance models, AR user experience design and features that influence consumer behaviour, and AR shopping experience and value theory. The resultant S-O-R-based conceptual framework highlights the functional and experiential elements needed for an effective consumer AR experience, which could be implemented by retailers seeking to engage consumers with an augmented shopping experience and make AR applications financially viable.

Originality: This is the first systematic literature review on AR in retail settings to include multiple disciplinary perspectives (HCI and marketing/management) and research methodologies.

Keywords:

Augmented reality, Retail technology, Customer experience, Systematic literature review

1. Introduction

Augmented reality (AR) has emerged as an important interactive sensory-enabling technology within retail environments (Javornik, 2016a; Petit *et al.*, 2019). By overlaying computer-generated graphics onto consumers' bodies or real-life surroundings in real-time (Javornik, 2016a), AR facilitates a digitally-enhanced perception of reality, combining real-world details with virtual visual effects. It can enrich the shopping experience, most commonly with virtual try-ons of clothing (e.g. J.C. Penney, Uniqlo, ASOS), footwear (e.g. Converse), accessories (e.g. Speedo goggles, Specsavers glasses) and cosmetics (e.g. Sephora, L'Oreal), as well as showcasing what items look like in consumers' homes (e.g. IKEA, Dulux). AR's interactive elements create an immersive shopping experience, giving consumers new ways to virtually interact with items (Suh and Prophet, 2018; Pantano *et al.*, 2017; Deloitte, 2020). As a form of customer service (Heller *et al.*, 2020), AR can help consumers evaluate products, encouraging purchases and minimising confusion (Pantano *et al.*, 2017; Hilken *et al.*, 2017; Chopra, 2019; Heller *et al.*, 2019a) and compensating for the lack of direct product contact when shopping online (Poshneh, 2018). When the COVID-19 pandemic mandated store closures and

accelerated the growth of online shopping, AR rapidly evolved from its gimmicky status to become an essential retail technology for virtual try-on in sectors such as beauty and jewellery that relied on direct product contact, resulting in significantly higher website conversion, increased basket size and reduced returns (Papagiannis, 2020; Drapers, 2020; Deloitte, 2020).

AR research has evolved from an initial emphasis on computing methodologies and human-computer interaction (HCI) (Azuma, 1997; Pantano and Servidio, 2012) to an emphasis on marketing-related opportunities and implications, particularly since 2014. The interdisciplinary nature of research on AR in retail has resulted in a fragmentation of the literature, giving an opportunity to gain a fuller understanding of its opportunities and challenges in terms of consumer behaviour and customer experience. A systematic literature review offers guidance on alternative directions for a future research agenda and is one of the most powerful ways of integrating fragmented literature (Tranfield *et al.*, 2003; Rousseau *et al.*, 2008). This paper synthesises the accumulated interdisciplinary knowledge on AR in retail settings from the domains of HCI and marketing/management to develop a holistic understanding of its practical use and a future research agenda. Research on AR in retail is nascent – only 5 reviews including 1 systematic review have been published so far (Javornik, 2016a; Bonetti *et al.*, 2018; Hilken *et al.*, 2018; Caboni and Hagberg, 2019; Perannagari and Chakrabarti, 2019), summarised in Table I.

Table I. Literature reviews on AR in retail settings

Authors	No. of papers reviewed	Focus of review	Type of review
Javornik (2016a)	44	Media characteristics of interactive technologies and consumer responses	Narrative

Bonetti <i>et al.</i> (2018)	35	Motives, practical applications and implementation of AR and VR by retailers and consumer acceptance	Narrative
Hilken <i>et al.</i> (2018)	20	AR's role as facilitator to promote omnichannel experiences throughout the shopping journey	Narrative
Caboni and Hagberg (2019)	65	AR definitions and potential value of AR retail applications for consumers and retailers	Narrative
Perannagari and Chakrabarti (2019)	35	Variables used in studies on AR's influence on consumer behaviour	Systematic

The earliest review by Javornik (2016a) focused on consumer responses to the media characteristics of AR apps, including but not limited to those in the retail sector. Bonetti *et al.*'s (2018) highly-cited book chapter focused on a comparison of AR and VR technologies. Hilken *et al.* (2018) focused on AR's role as an enabler of the omnichannel experience through situated cognition theory based on a small sample of 20 papers. Caboni and Hagberg (2019) reviewed AR in retailing within business-oriented research, focusing on AR's origins, development, definitions and elements. They suggested future research should provide a more in-depth and thematic understanding of various perspectives of AR as well as its potential value in retail. The most recent review, and the only systematic review in the sample, by Perannagari and Chakrabarti (2019) provided a thematic analysis of variables that influence consumer acceptance of AR which necessitated a narrow focus on empirical papers using surveys and statistical analysis, eliminating qualitative forms of enquiry or wider issues relating to AR in retail. Although previous reviews have contributed notably to the field, a more comprehensive and systematic review of the broader literature base relating to AR in retail environments is warranted given the sharp increase in published studies within the last two years.

Systematic literature reviews are more objective, rigorous, transparent and less biased (Boell and Cecez-Kecmanovic, 2015), offering opportunity for theoretical synthesis of the field (Tranfield *et al.*, 2003).

2. Research Approach

The literature search and selection process followed a two-stage approach (Boell and Cecez-Kecmanovic, 2015) to reduce bias and ensure replicability (Tranfield *et al.*, 2003), following similar reviews on immersive technologies (Suh and Prophet, 2018; Radianti *et al.*, 2020). An initial keyword search to identify relevant articles was followed by the application of more rigorous inclusion and exclusion criteria.

The first step of keyword identification enabled the location of relevant studies published in peer-reviewed English language journals across HCI and marketing/management disciplines, to increase the reliability of the research. HCI and consumer-related search terms such as “augmented reality”, “AR”, “retailing”, “consumer behaviour”, “customer experience”, “user experience”, “UX design”, “human factors” were identified from previous research (e.g. Hilken *et al.*, 2018; Perannagari and Chakrabarti, 2019; Cruz *et al.*, 2019; Jenssen *et al.*, 2020) and used to search Google Scholar, Elsevier, Emerald, Scopus and Web of Science databases (Caboni and Hagberg, 2019; Perannagari and Chakrabarti, 2019) from 1997, when the first academic review on AR was published (Azuma, 1997) until 31 December 2020. Next, articles were limited to those in the field of marketing/management or those incorporating human factors. To ensure source credibility (Podsakoff *et al.*, 2005), only journals with a Q1 or Q2 ranking in the SJR journal ranking system and/or presence in the Association of Business Schools (ABS)

Academic Journal Guide 2018 were included, to reflect the highest quality journals in their respective fields. A manual search step ensured articles in leading journals were captured, as shown in Figure 1.

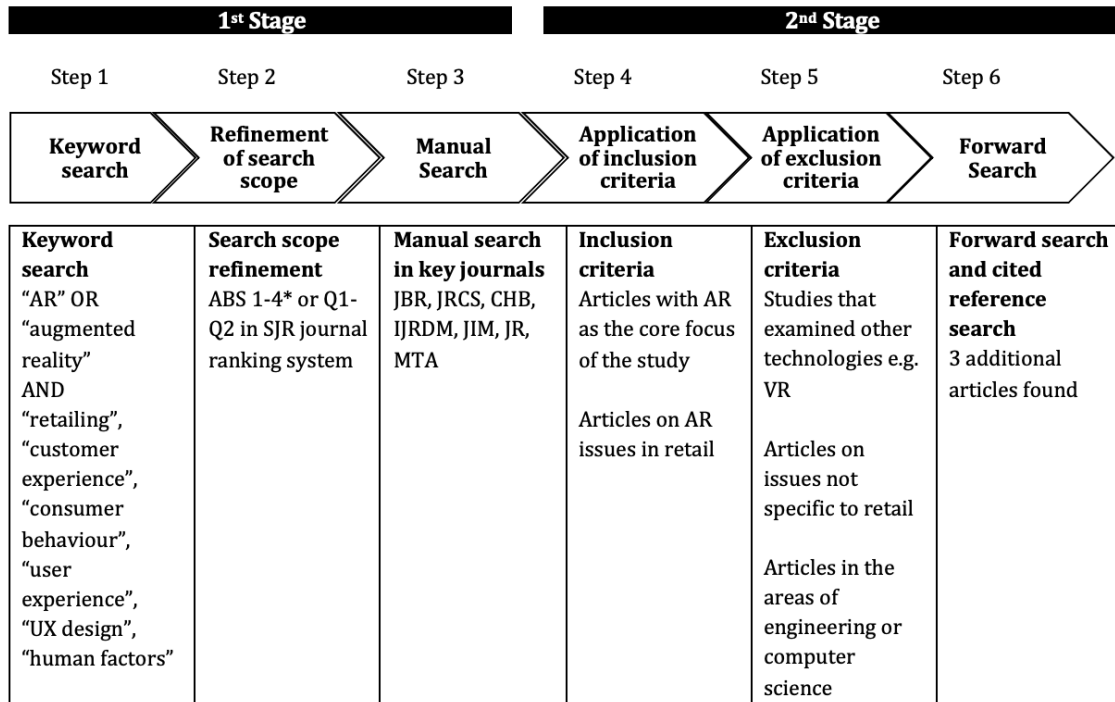


Figure 1. Literature search and selection process

The second step was to apply inclusion and exclusion criteria after reviewing the relevance of the abstract and the main text in relation to the keywords. Studies included had AR as the core focus and addressed issues regarding AR in retail. Studies that examined other immersive technologies, had no specific focus on retail, or focused on engineering or computer science were eliminated. Based on these criteria, 72 relevant research articles were identified. A forward search of identified articles found two additional papers. The search terms were then checked in an additional search engine, EBSCO, to ensure all key studies were identified. Cited references were used as a

secondary source, but only yielded two additional papers, reinforcing the validity of the search process.

The final sample of 76 papers was downloaded into NVivo 12, reviewed in chronological order and manually coded by highlighting statements relating to theories applied to AR in retail, AR shopping environments or AR customer experience. These key terms were synthesised into the dataset to form the underlying research themes. Using NVivo 12 to construct, examine and revisit the themes, papers were thematically analysed in relation to the main focus, research gaps, key findings, methodologies and limitations. Thematic analysis is a qualitative method for identifying, analysing and reporting patterns (themes) found within a dataset (Braun and Clarke, 2006) but is suitable for multiple epistemologies and research questions (Nowell *et al.*, 2017).

3. Overview and Descriptive Synthesis

3.1 Distribution across time period and main journals

Figure 2 shows a chronological increase in published works on AR in retail, with significant growth from 2014 and 2019, which can be explained by the increased development of AR technology, facilitating access to lower-cost AR applications, alongside smartphone technology, providing retailers with more options for AR mobile apps (Javornik, 2016a; Dacko, 2017; Plotkina and Saurel, 2019). 18 articles were identified in 2019 (including 2 reviews) and 17 articles in 2020 (including those accepted and published online ('early-cite') but not yet assigned to a volume and issue).

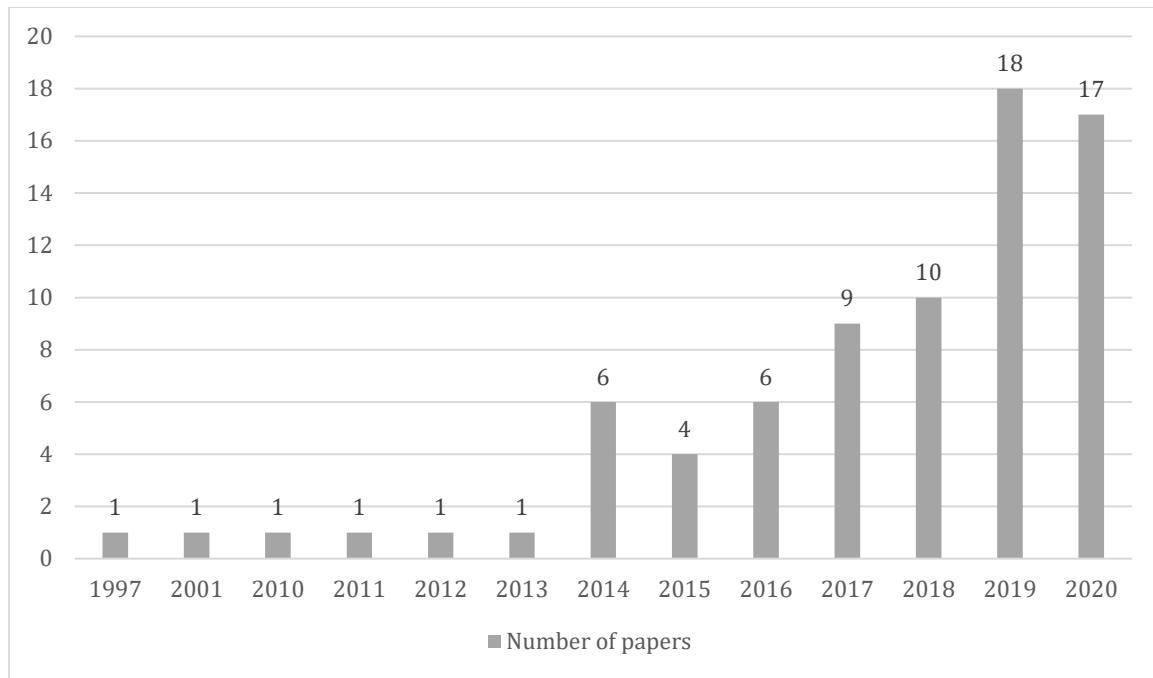


Figure 2. Distribution of publications per year

Papers originated primarily from marketing and business journals, as shown in Figure 3, demonstrating the increasing interest from retail marketing scholars.

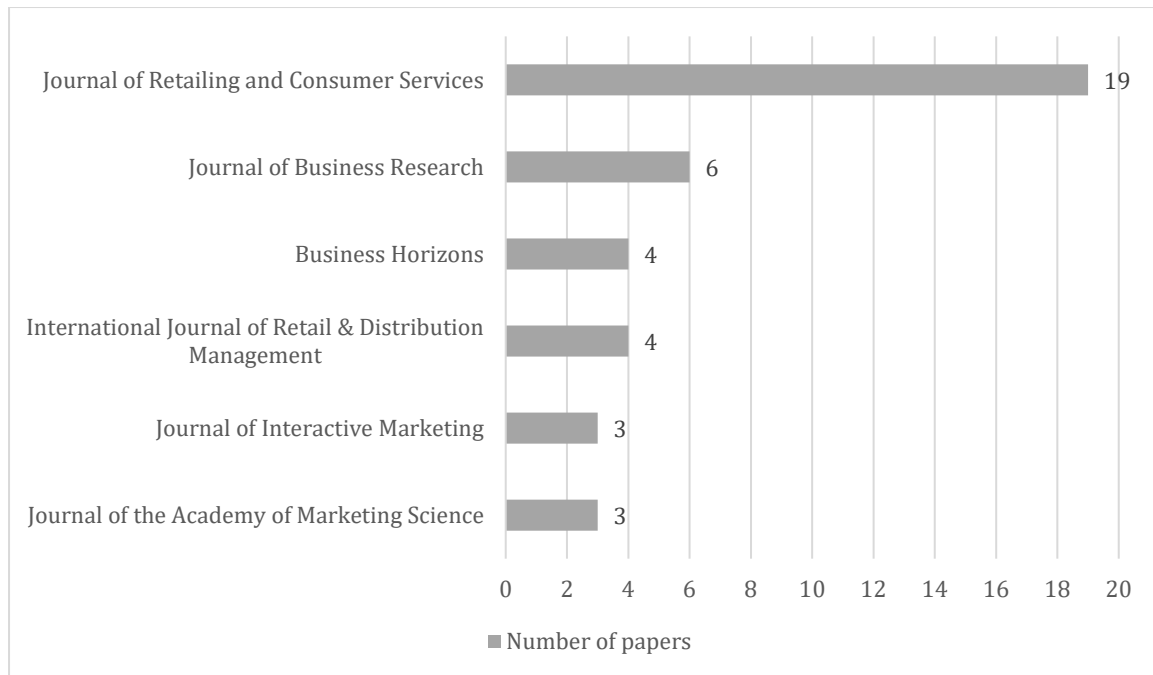


Figure 3. Key journals publishing AR in retail research

3.2 Research methodologies

Surveys, interviews, theoretical and conceptual papers, experiments, literature reviews, observations and mixed methods papers make up the research methodologies, as shown in Figure 4.

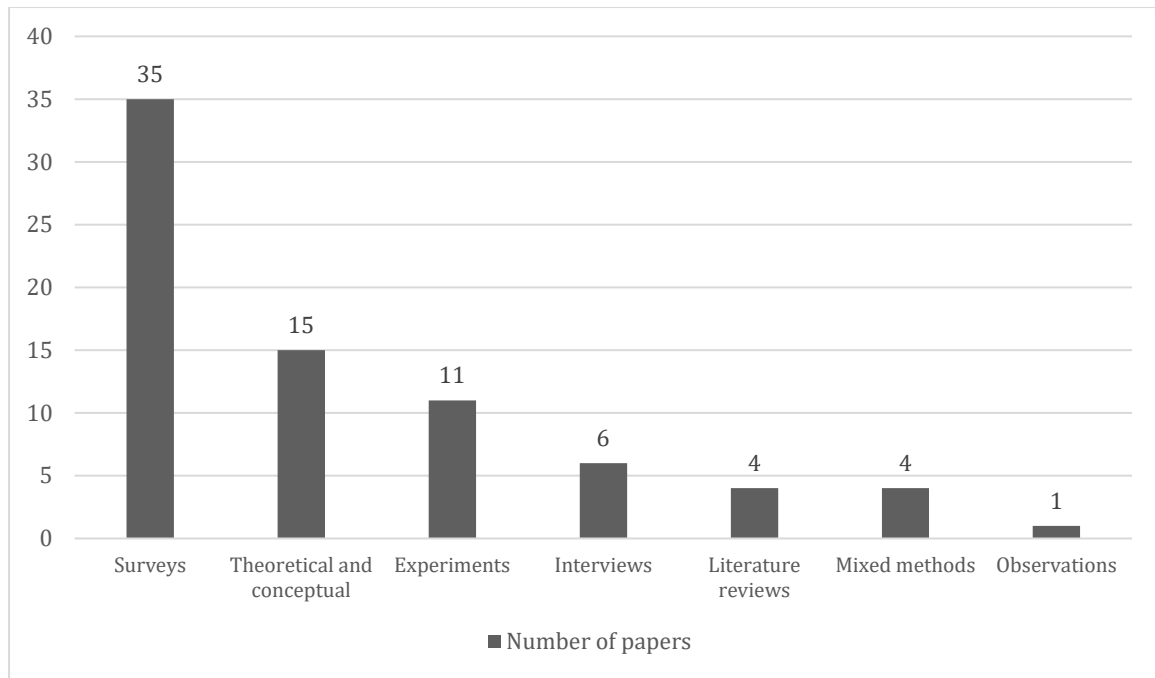


Figure 4. Distribution of research methodologies

Most (60.5%) used quantitative methods (surveys or experiments), 25% were conceptual or review papers and 9% used qualitative approaches (interviews or observations). Only 4 papers conducted mixed methods research (Parise *et al.*, 2016; Poushneh, 2018; Rauschnabel *et al.*, 2018; Plotkina and Saurel, 2019). Earlier conceptual papers were followed by more empirical research after 2014, while more recent attempts to conceptualise and reconceptualise AR in retail and marketing reflect the continual evolution of the topic field (e.g. Chylinksi *et al.*, 2020; Hilken *et al.*, 2020; Hinsch *et al.*, 2020; Smink *et al.*, 2020). Surveys and experimental research (e.g. Cho and Schwarz, 2010; Pincon and Mimoun, 2014; Huang and Liao, 2015) were published earlier than qualitative studies (e.g. Scholz and Duffy, 2018; Chopra, 2019; Cuomo *et al.*, 2020; Romano *et al.*, 2020).

3.3 Current AR in retail research foci

Figure 5 displays the main research areas explored in the sample, summarising the focus of research to date.

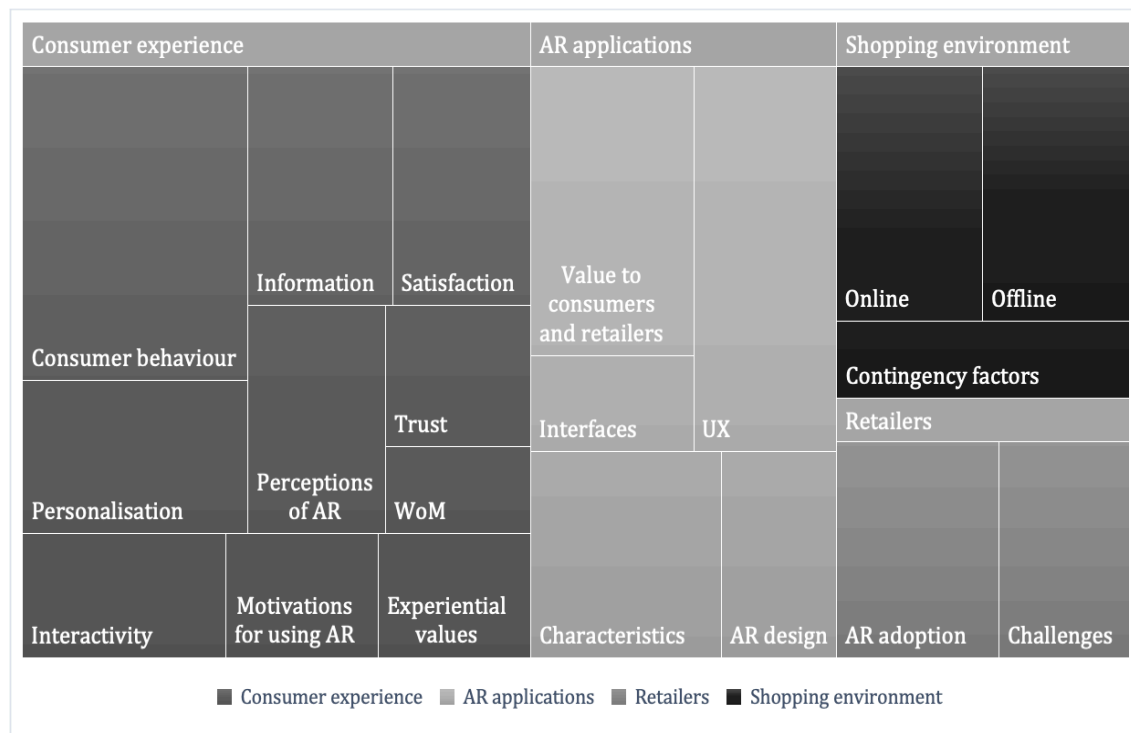


Figure 5. Hierarchy chart of AR in retail research foci

Most research on AR in retail is consumer-based and most of those studies concluded that consumers respond positively to AR in retail settings. AR's enhancement of the shopping experience has many marketing-relevant outcomes such as reducing decision-making uncertainty (Dacko, 2017; Chopra, 2019; Baytar et al., 2020; Park and Yoo, 2020) increasing purchase intention (Javornik, 2016b; Plotkina and Saurel, 2019), building customer loyalty (Poushneh *et al.*, 2017) and facilitating consumer-brand relationships (Scholz and Duffy, 2018; Huang, 2019; Smink et al., 2020). However, consumer take-up has been slow and many businesses remain cautious (Yim and Park, 2019; Chylinkski *et*

al., 2020), highlighting the need for improvements in AR platform and user experience design (Scholz and Smith, 2016; Chylinski *et al.*, 2020) to deliver value.

Many articles suggest that retailers need to better understand how to embrace AR applications and the characteristics that impact the AR customer experience, such as augmentation (Javornik, 2016a; Hilken *et al.*, 2017), interactivity (Parise *et al.*, 2016; Yim *et al.*, 2017), personalisation (Parise *et al.*, 2015; Chopra, 2019), vividness (Yim *et al.*, 2017) and user experience (Poushneh and Vasquez-Parraga, 2017), all of which must be considered when creating AR shopping environments (Yim *et al.*, 2017). Contingency factors such as perceived body image (Yim and Park, 2019) and privacy concerns (Hilken *et al.*, 2017; Poushneh, 2018) may negatively influence the AR shopping experience,

The third critical area relates to the value of AR for consumers and the AR shopping environment. AR can enhance the shopping experience by providing hedonic and utilitarian value, as well as improving the decision-making process, leading to positive behavioural intentions (Dacko, 2017; Hilken *et al.*, 2017; Yim *et al.*, 2017) by helping customers at different stages in their shopping journey (Jessen *et al.*, 2020; Romano *et al.*, 2020). However, AR could also have a negative effect on the shopping experience, due to technical limitations or low quality representation (Plotkina and Saurel, 2019), perceived intrusiveness (Smink *et al.*, 2020) and privacy concerns (Hilken *et al.*, 2017; Poushneh, 2018; Rauschnabel *et al.*, 2018).

4. Results and Discussion

Three interconnected research themes emerged from the systematic review, shown in Table II.

Table II. Key research themes

Research Themes	Indicative Articles
AR adoption-based factors with Technology Acceptance Models	Pantano and Servidio, 2012; Rese <i>et al.</i> 2014; Huang and Liao, 2015; Kim <i>et al.</i> , 2017; Rese <i>et al.</i> 2017; Holdack <i>et al.</i> , 2020
AR UX design and AR features that influence consumer behaviour	Huang and Hsu Liu, 2014; Yaoyuneyong <i>et al.</i> 2014; Huang and Liao, 2015; Javornik, 2016a,b; Hilken <i>et al.</i> 2017; Poushneh and Vasquez-Parraga, 2017; Yim <i>et al.</i> 2017; Beck and Cri��, 2018; Yim and Park, 2019; Baytar <i>et al.</i> 2020; Fan <i>et al.</i> 2020; Heller <i>et al.</i> 2020; Park and Yoo, 2020; Yang <i>et al.</i> 2020
AR shopping experience and value theory	Olsson <i>et al.</i> 2013; Poncin and Mimoun, 2014; ; Javornik, 2016b; Dacko, 2017; Hilken <i>et al.</i> 2017; Hilken <i>et al.</i> 2018; Poushneh, 2018; Scholz and Duffy, 2018; Watson <i>et al.</i> 2018; Heller <i>et al.</i> 2019a,b; McLean and Wilson, 2019; Simnk <i>et al.</i> 2019; Chylinski <i>et al.</i> 2020; Heller <i>et al.</i> 2020; Jessen <i>et al.</i> 2020; Simnk <i>et al.</i> 2020

4.1 AR adoption-based factors with Technology Acceptance Models

One of the most considered areas of research in AR in retail is adoption-based aspects using Davis's (1989) Technology Acceptance Model (TAM) (e.g. Pantano and Servidio,

2012; Huang and Liao, 2015; Holdack *et al.*, 2020). TAM's explanative powers are valuable in researching consumer acceptance of AR (Huang and Liao 2015) and adoption problems (Rese *et al.*, 2017), including both hedonic and utilitarian aspects (Huang and Liao, 2015; Javornik, 2016b; Rese *et al.*, 2017). Perceived usefulness (PU) and perceived ease of use (PEOU) encapture utilitarian values while perceived enjoyment (PE) reflects hedonic and experiential values. These values are interrelated, in that enjoyment is stronger when technology is easy to use (Pantano and Servidio, 2012). TAM remains a viable method to investigate acceptability and potential use (Rese *et al.*, 2017; Perannagari and Chakrabarti, 2019; Plotkina and Saurel, 2019), continued usage (Huang and Liao, 2015) and for novel AR applications such as smart glasses (Holdack *et al.*, 2020), as shown in Table III.

Table III. Research on consumer adoption of AR in retail

Authors	Theory/ Model	Application	Variables
Pantano and Servidio, 2012	TAM	Immersive store	PEOU, PU, PE, Satisfaction, Perception
Poncin and Mimoun, 2014	S-O-R	Magic mirror	Perceived store atmosphere, Satisfaction, Patronage intention, Perceived value, Positive emotion
Rese <i>et al.</i> 2014	TAM	AR app	PE, PI, PEOU, PU, AT, BI
Huang and Liao, 2015	TAM	Virtual try-on	PEOU, PU, PE, Playfulness, Aesthetics, Service Excellence
Javornik, 2016b	Media Effects	Virtual try-on	BI, Cognitive and affective responses, Flow
Kim <i>et al.</i> , 2017	TAM	Magic Mirror	PEOU, PU, PE, AT, BI
Rese <i>et al.</i> 2017	TAM	AR app	PI, PEOU, PU, PE, AT, BI

Plotkina and Saurel, 2019	TAM	Virtual try-on AR app	PI, PEOU, PU, PE
Holdack <i>et al.</i> , 2020	TAM	Smart glasses	PI, PEOU, PU, PE, AT, BI

The importance of joy-related elements (Holdack *et al.*, 2020) confirms earlier work on PE and experiential value of AR in retail (Dacko, 2017; Scholz and Duffy, 2018). Additional AR-related constructs such as playfulness, augmentation quality, interactivity and personalisation have been added to TAM to provide more specific adoption criteria (Perannagari and Chakrabarti, 2019; Pantano *et al.*, 2017) for a better understanding of AR features and their role in impacting utilitarian and hedonic values (Poushneh and Vasquez-Parraga, 2017). However, the rapid development of AR in retail and its growing popularity among customers has accelerated the need for retailers to gain a better understanding of the impact of AR on consumer behaviour beyond mere adoption (Li *et al.*, 2020). Arguably, some consumers have moved beyond PEOU and PU as they have a greater level of familiarity with AR (Moriuchi *et al.*, 2020), leading to renewed focus on the experiential value of AR (Hoyer *et al.*, 2020) to help or hinder the purchase journey (Romano *et al.*, 2020) and the use of Mehrabian and Russell's (1974) Stimulus-Organism-Response (S-O-R) model (Watson *et al.*, 2018; Baytar *et al.*, 2020) rather than TAM. Recent studies have focused on how AR features create hedonic value to enhance the shopping experience (Park and Yoo, 2020), improve customer engagement (Jessen, 2020) and positively impact customer-brand relationships (Smink *et al.*, 2020).

4.2 AR UX design and AR features that influence consumer behaviour

Table IV illustrates how AR UX perspectives have evolved over time.

Table IV. AR user experience (UX) design research

Studied Issues	Authors
Application of AR in retail and other industries and how AR collaborations influence user experience (UX); privacy issues and quality of AR applications	Carmigniani <i>et al.</i> (2011) Poushneh (2018)
User expectations for AR UX design solutions are multi-dimensional and influenced by several parts of the technology	Olsson <i>et al.</i> (2013)
Sharing personalised experience with the help of AR on users' social media could develop playfulness	Huang and Hsu Liu (2014)
AR UX design should be shaped by customer insights about their experiences of AR	Scholz and Smith (2016)
AR's impact on UX and consequent impact on user satisfaction and willingness to buy	Poushneh and Vasquez-Parraga (2017)
AR increases users' abilities to fulfil their needs. Augmentation quality and control of personal information shape users' attitudes towards UX	Poushneh (2018)
AR positively affects UX by improving users' information processing	Fan <i>et al.</i> (2020)

Significant insights into the AR UX have been provided by previous studies (e.g. Poncin and Mimoun, 2014; Javornik, 2016b; Hilken *et al.*, 2017; Poushneh and Vasquez-Parraga, 2017). Prior research mainly focused on AR mobile apps to explore consumer motivations for using AR (e.g., Javornik, 2016b; Hilken *et al.*, 2017; Yim *et al.*, 2017; Beck and Cri  , 2018; Poushneh, 2018). However, these predominantly focus on the immediate responses of consumers towards AR content and highlight very specific aspects of the

consumer journey rather than taking a holistic approach. Understanding of AR features which impact UX from a HCI perspective (Erra *et al.*, 2018) is scarce but important due to the commercial benefits that can be gained through effective interface design and its potential to influence consumer behaviour (Olsson *et al.*, 2013; Scholz and Smith, 2016; McLean and Wilson, 2019; Jessen *et al.*, 2020).

4.2.1 AR Characteristics

Research shows that interactive, immersive AR interfaces, easy access, personalised experiences and user-orientated applications are important for positively affecting UX. Key AR characteristics for retail applications are highlighted in Table V.

Table V. AR core characteristics

AR Characteristics	Authors
Interactivity	Javornik, 2016b; Parise <i>et al.</i> 2016; Yim <i>et al.</i> 2017; Poushneh, 2018; Yim and Park, 2019; Park and Yoo, 2020
Augmentation	Javornik, 2016b; Watson <i>et al.</i> 2018
Immersion	Huang and Liao, 2015; Javornik, 2016a,b; Huang and Liao, 2017
Vividness	Yim <i>et al.</i> 2017
Personalisation	Parise <i>et al.</i> 2016; Chopra, 2019

These characteristics have been explored in relation to consumer responses towards AR, with particular emphasis on interactivity (Yim *et al.*, 2017) and immersion (Javornik, 2016a,b). A positive affective reaction is created by interactivity as it entertains and immerses users (Yim and Park, 2019). Augmentation also plays a significant role in

promoting excitement, playfulness and immersion, thus enhancing experiential value creation (Javornik, 2016a; Poushneh and Vasquez-Parraga, 2017; Erra *et al.*, 2018).

4.3 AR shopping experience and value theory

AR experiences can be classified as embedded, embodied, shared and adaptive experiences and there is a broad variety of research into the potential of embedded and embodied AR experiences to shape consumer behaviour (Chylinski *et al.*, 2020). AR allows for greater customer satisfaction, resulting in more meaningful customer engagement (Jessen *et al.*, 2020), facilitating the decision-making process and enhancing consumer understanding through the digitilisation of service (Huang and Liao, 2015; Parise *et al.*, 2016; Heller *et al.*, 2020). Table VI summarises the value of AR for the customer experience and relevant contingency factors.

Table VI. Selected literature on the effects of AR on customer experience

Customer Experience	Authors	Findings
Cognitive and emotional fit	Parise <i>et al.</i> 2016	AR stimuli provide emotional and cognitive content that enables a personalised experience according to shoppers' needs and requirements for information
Flow	Javornik, 2016b; Parise <i>et al.</i> 2016	AR can improve flow between customer contact points
Immersion	Parise <i>et al.</i> 2016; Yim <i>et al.</i> 2017	AR can convert to a completely new level because of the immersion it offers the user

Spatial presence	Hilken <i>et al.</i> 2017; Smink <i>et al.</i> 2020	Consumer expectations for utilitarian value could be stronger for those who process information orally (not visually) due to the influence of spatial presence
Hedonic value	Poncin and Minmoun, 2014; Rese <i>et al.</i> 2014; Dacko, 2017; Hilken <i>et al.</i> 2017; Yim <i>et al.</i> 2017; Rauschnabel <i>et al.</i> 2019; Romano <i>et al.</i> , 2020	Hedonic value drives consumers' attitudes and reactions towards their AR experience AR shopping experience perceived as more fun
Learning information	Parise <i>et al.</i> 2016; Dacko, 2017	AR provides users with an easier way to learn product information Some users are also interested in gathering data from AR systems, including friends and family references
Satisfaction	Poncin and Mimoun, 2014; Parise <i>et al.</i> 2016; Dacko, 2017; Yim and Park, 2019; Jessen <i>et al.</i> 2020	AR shopping experience has potential to facilitate customer satisfaction by increasing product tangibility and purchase confidence, leading to customer loyalty
Utilitarian value	Olsson <i>et al.</i> 2013; Poncin and Mimoun, 2014; Dacko, 2017; Yim <i>et al.</i> 2017, Rauschnabel <i>et al.</i> , 2019, Romano <i>et al.</i> , 2020	Utilitarian value influences consumers' use of AR, especially when they find it playful and enjoyable
Contingency factors that impact customer experience		
Privacy concerns	Olsson <i>et al.</i> 2013; Dacko, 2017; Hilken <i>et al.</i> 2017; Rauschnabel <i>et al.</i> 2018;	Privacy concerns are a potential drawback Lack of consumer control over personal data could decrease satisfaction of AR experience

	Poushneh, 2018; de Ruyter <i>et al.</i> , 2020	Consumer privacy concerns present a challenge for AR advertising contextualisation
Information processing	Hilken <i>et al.</i> 2017; Fan <i>et al.</i> , 2020	Style of information processing varies among people, resulting in different consumer evaluations of AR experience
Use of AR in public vs. private settings	Rauschnabel <i>et al.</i> 2018; Scholz and Duffy, 2018; Carrozzi <i>et al.</i> , 2019	Use of AR applications can generate different consumer experiences in various environments e.g. home vs. store
Product category	Yim <i>et al.</i> , 2017	Respondents found AR much more successful for sunglasses than watches, as seeing themselves with AR sunglasses on was similar to looking in a mirror, whereas holding their wrist up to a web-cam for the watch irritated them
Narcissism	Baek <i>et al.</i> , 2018	Narcissism intensifies AR's effects on self-brand connections and purchase intention
Anthropomorphism	van Esch <i>et al.</i> , 2019	Anthropomorphism significantly influenced constructs related to AR except discomfort
Body image perception	Yim and Park, 2019	Consumers with poor body image perceptions are more favourable in their evaluations of AR-based virtual try-on

AR provides both hedonic and utilitarian value, as well as improving the consumer purchase decision-making process, leading to positive behavioural intentions and facilitating customer engagement throughout the shopping journey whether at home or

in-store (Yim *et al.*, 2017; Sholz and Duffy, 2018; Crue *et al.*, 2019; Jessen *et al.*, 2020). However, Scholz and Duffy (2018) argued that despite consumers perceiving AR shopping favourably, the buying experience may not be pleasant or valued, while Rauschnabel *et al.* (2019) found that consumers felt less compelled to buy despite finding the AR shopping experience more fun. The disparity between shopping in the real and augmented world can be difficult for consumers to understand (Heller *et al.*, 2019b), so retailers must deliver practical, easy-to-use (Poushneh and Vasquez-Parraga, 2017) AR shopping experiences for the technology to deliver true value (Dacko, 2017; Romano *et al.*, 2020; Smink *et al.*, 2020). Recent studies address an increasing variety of contingency factors that influence AR experiences, from personal traits to situational contexts.

4.3.1 AR customer experience consequences

An excellent AR consumer experience leads to positive consequences for consumers and retailers, as summarised in Table VII.

Table VII. Selected literature on AR customer experience consequences

Experience consequences		Authors	Findings
Decision-making	Decision comfort	Hilken <i>et al.</i> 2017	AR-based service augmentation created spatial presence to increase value perceptions and consumers' decision comfort
	Purchase confidence	Dacko, 2017; Hilken <i>et al.</i> 2020	Users benefit from more detailed product information, more selection, greater buying trust, the opportunity to "check" products prior to purchase and more customised items Social AR supports shared decision-making
	Purchase satisfaction	Dacko, 2017; Jessen <i>et al.</i> 2020	Improved purchasing satisfaction, including enhanced sales chances, WOM, in-store visits and customer satisfaction

	Perception of reduced risk	Yaoyuneyong <i>et al.</i> 2014; Rauschnabel <i>et al.</i> 2018	Perceived risk dimensions are significantly reduced due to AR's ability to provide more product information
Behavioural intentions	Engagement	Parise <i>et al.</i> 2016; Jessen <i>et al.</i> 2020	AR helps to co-create interest and drive positive brand engagement with a high level of customer satisfaction
	Loyalty	Dacko, 2017	AR shopping apps can create fun customer experiences to ensure high satisfaction and loyalty
	Purchase intention	Javornik, 2016b; Parise <i>et al.</i> 2016; Dacko, 2017; Hilken <i>et al.</i> 2017; Yim <i>et al.</i> 2017	Enhanced perception of value for the AR-based increase in service translates into behavioural responses Link between immersion and consumer learning and buying intentions
	Re-visit	Poncin and Mimoun, 2014; Javornik, 2016b; Dacko, 2017	AR enhances shopping efficiency by creating a new impact, which attracts consumer attention AR virtual try-on app positively impacts behavioural intention to re-visit
	WOM	Javornik, 2016b; Dacko, 2017; Hilken <i>et al.</i> 2017; Heller <i>et al.</i> 2019a	AR shopping experience may lead to higher shopper engagement and greater positive WOM
Brand and mobile app perceptions	Attitude towards mobile app	Javornik, 2016b; Yim <i>et al.</i> 2017; Scholz and Duffy, 2018	Greater media usefulness and consumer pleasure when using AR led to a more positive attitude towards AR Degree of immersiveness of AR apps and how realistic the digital content looks relates to variables such as user satisfaction, AR device behaviour and readiness to buy
	Motivation	Javornik, 2016a; Huang and Liao, 2017; Beck and Cri��, 2018;	Consumers with hedonic shopping motivations can use AR to enhance their experience

Brand attitude	Javornik, 2016b; Scholz	Virtual experience offers better brand awareness (cognitive
	and Duffy, 2018;	response) than direct experience
	Rauschnabel <i>et al.</i>	AR applications may promote more than transactional
	2019; Smink <i>et al.</i>	consumer-brand relationships
	2019; Huang, 2019;	Anthropomorphism in AR can help to improve consumers'
	van Esch <i>et al.</i> 2019;	attitude toward the brand
	Smink <i>et al.</i> 2020	

Clearly, AR can improve consumers' decision-making process and lead to positive behavioural intentions resulting from a better shopping experience (e.g., Hilken *et al.*, 2017; Yim *et al.*, 2017), but despite predictions about AR's bright future, consumer take-up has been slow (Yim and Park, 2019; Chylinski *et al.*, 2020). However, few studies focus on the negative aspects of AR in retail, such as post-purchase cognitive dissonance (Romano *et al.*, 2020), media irritation (Yim and Park, 2019), technological limitations (Yim *et al.*, 2017; Plotkina and Saurel, 2019) and privacy concerns (Dacko, 2017; Hilken *et al.*, 2017; Rauschnabel *et al.*, 2018; de Ruyter *et al.*, 2020).

5. Towards a conceptual framework

The S-O-R model (Mehrabian and Russell, 1974) was used as an overarching conceptual framework to summarise the role of AR on the retail customer experience and outline a future research agenda. Whilst many previous studies have used Davis's (1989) TAM, as AR has become more widely adopted and accepted, further research should focus on how it affects cognitive and emotional states and impacts shopping experience and behaviour. Many studies have demonstrated that AR features drive specific actions such as

behavioural intentions (Poushneh and Vasquez-Parraga, 2017; Watson et al., 2018; McLean and Wilson, 2019; Rauschnabel et al., 2019; Baytar et al., 2020; Fan et al., 2020; Park and Yoo, 2020). Watson et al. (2018) and Baytar et al. (2020) argued that the S-O-R model is particularly suited to understand how AR attributes impact behavioural intentions. It is a robust model (Watson *et al.*, 2018) that has been applied in previous studies on AR and consumer behaviour (Poncin and Mimoun, 2014; Parise *et al.*, 2016; Watson *et al.*, 2018; Baytar *et al.*, 2020) and to summarise a literature review on immersive technologies (Suh and Prophet, 2018). The unique features of AR can create rich sensory experiences and influence mental imagery (Heller *et al.*, 2019a), acting as triggers (S) of a consumer's value evaluation (hedonic value), which lead to positive emotional and behavioural consumer responses (Watson *et al.*, 2018; Park and Yoo, 2020). Building on this logic, the S-O-R model is suitable for current study as *"when an individual encounters a stimulus (S), he/she develops internal states (O), which in turn dictates his/her responses (R)"* (Mehrabian and Russell, 1974, p.298). Consequently, the discussion of research themes culminates in a conceptual framework (Figure 6) based on the S-O-R model to illustrate AR's potential to enhance retail customer experience and highlight the elements of AR that are critical for consumer experience as well as potential downsides, which can be catalysts for future research.

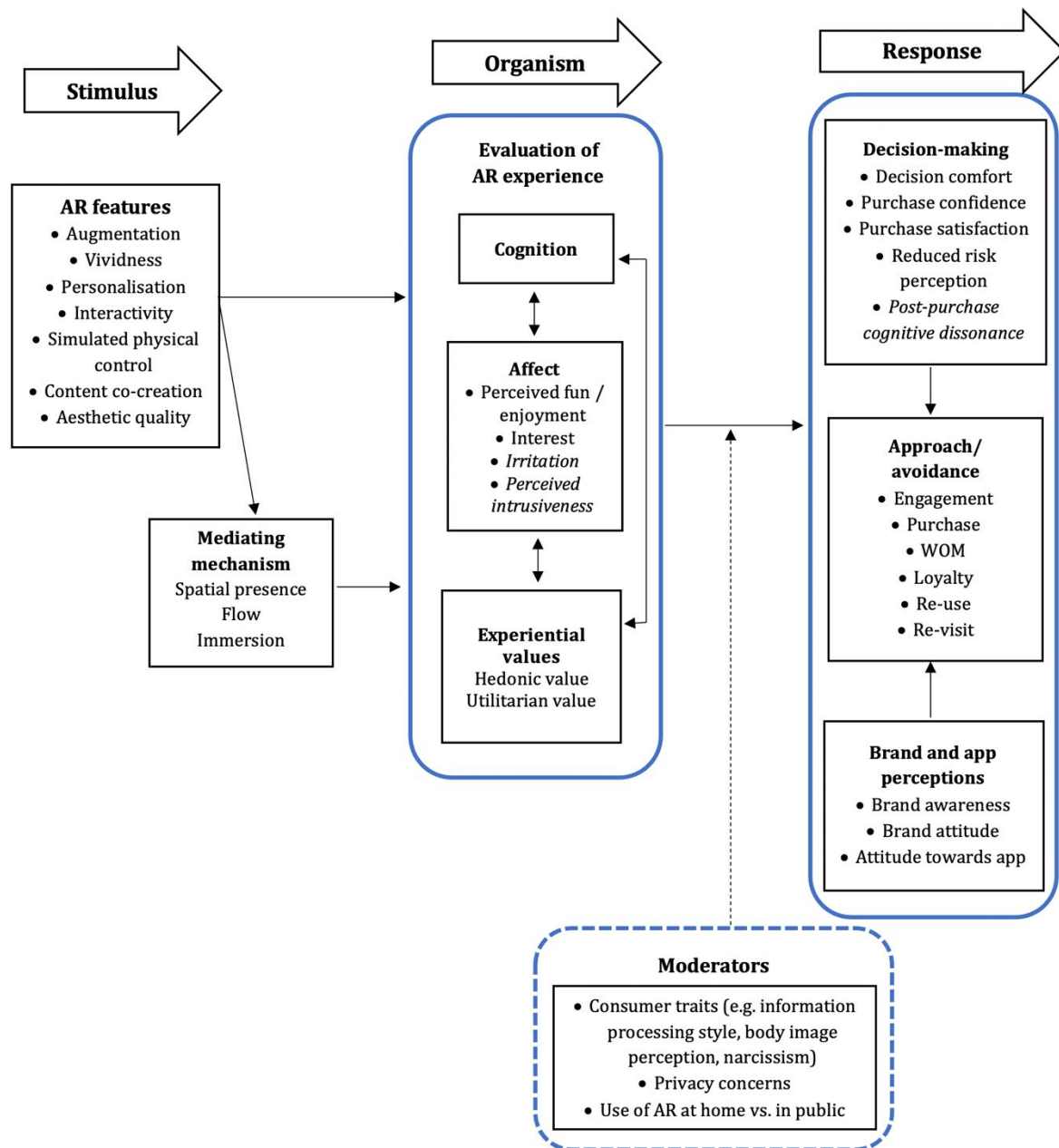


Figure 6. S-O-R based conceptual framework of consumer experience, experiential values, and consumer behaviour of AR in retail settings

As the literature shows that AR is a design feature, the conceptual framework begins with AR features as the stimulus (S), following Watson *et al.* (2018). Design features act as environmental stimuli as they have a crucial influence on whether and how customers

engage with technology (Venkatesh *et al.*, 2016). AR's distinct characteristics and features make it unique, functional and appealing to users by creating experiential values (Rauschnabel *et al.*, 2019). Interactivity and vividness are unique attributes of AR due to their implied ability to positively impact consumer's hedonic values (Yim *et al.*, 2017; McLean and Wilson, 2019). The framework highlights how interactivity creates experience by immersing the user in a highly absorbing state through its ability to produce flow (Javornik, 2016b). Flow and value themes are related to cognitive responses (O) associated with technology usage. The S-O-R model shows that environmental stimuli influence the user's internal states by triggering a cognitive and affective response which impacts consumer decision-making and behavioural responses. AR affects consumers' cognitive and emotional/affective states (Parise *et al.* 2016) and experiential values (both hedonic and utilitarian) (Olsson *et al.* 2013; Poncin and Mimoun, 2014; Rese *et al.* 2014; Dacko, 2017; Hilken *et al.* 2017; Yim *et al.* 2017, Rauschnabel *et al.* 2019; Romano *et al.*, 2020).

In line with Perannagari and Chakrabarti's (2019) placement of moderators between affective and behavioural responses, the current framework situates the moderating variables between cognitive responses (O) and behavioural outcomes (R). Consumer traits such as perceived body image (Yim and Park, 2019), narcissism (Baek *et al.* 2018), information processing style (Hilken *et al.* 2017; Fan *et al.* 2020), privacy concerns (Olsson *et al.* 2013; Dacko, 2017; Hilken *et al.* 2017; Rauschnabel *et al.* 2018; de Ruyter *et al.*, 2020) and situational contexts (Rauschnabel *et al.* 2018; Scholz and Duffy, 2018; Carrozzi *et al.*, 2019) moderate the outcomes of consumers' internal processing of AR experiences.

The concluding element of the S-O-R model represents the final consumer behavioural outcome. AR impacts consumers' internal states, which then influence consumer decision-making, such as purchase confidence (Dacko, 2017) and reduced risk perception (Yaoyuneyong *et al.* 2014; Rauschnabel *et al.* 2018), behavioural intentions and responses, such as purchase intention (Javornik, 2016b; Parise *et al.* 2016; Dacko, 2017; Hilken *et al.* 2017; Yim *et al.* 2017), word-of-mouth (Javornik, 2016b; Dacko, 2017; Hilken *et al.* 2017; Heller *et al.* 2019a) and perceptions of the brand or mobile app (Javornik, 2016b; Yim *et al.* 2017; Scholz and Duffy, 2018).

6. Future research agenda, implication for theory and practice

6.1 Future Research Agenda and Theoretical Implications

The pandemic made online shopping more important than ever, leading to a unique opportunity to focus on the evolving value of AR to provide new and practical solutions in response to lockdown closures of non-essential stores. Studies of AR applications in online retail will be particularly valuable, as will studies on product categories or user cohorts that exist in practical retail applications but are not yet considered in academic research, such as the role of AR in reducing online returns, the effectiveness of AR for sustainability storytelling or virtual events and the growth of AR-enabled virtual clothing. Several research directions in each theme are recommended.

- *AR adoption-based factors and UX design post-pandemic*

Studies from 2016 onwards call for further knowledge of AR UX design, which is even more imperative post-pandemic as a greater variety of people have had the opportunity to use the technology, not only digital natives, when AR was more widely adopted in

sectors such as cosmetics which pre-pandemic required physical contact to experience. AR adoption-based research could be broadened to older age groups and move beyond laboratory settings to field research with actual consumers. Research should move beyond adoption to uncover how consumers want to use AR throughout their shopping journey (Chylinski *et al.*, 2020). AR interface features which can influence users' attitudes (i.e. emotional and cognitive) towards AR is part of a growing research context that calls for the development of more effective and efficient AR platforms (e.g. Javornik, 2016a; Scholz and Smith, 2016), highlighting the value of AR UX design in improving social, utilitarian and hedonic value. Further research should take a holistic focus on AR UX to provide richer insight than possible with fragmented consumer reactions focused on the latter stages of the purchase journey or app-related responses (Javornik, 2016b; Jessen *et al.*, 2020; Chylinski *et al.*, 2020). There is very little practitioner-focused research, therefore incorporating retailer and AR developer perspectives of the value of AR, as distinct from other marketing approaches, in shaping consumer behaviour (Chylinski *et al.*, 2020) is recommended to further understanding of the current state, drivers and obstacles of AR for retailers.

- *AR shopping experience and value theory*

While single retail channels are prevalent in the literature, further research is needed to extend understanding of AR's value in omnichannel contexts (Hilken *et al.*, 2018), which emphasise personalisation to provides seamless experiences across channels. AR blurs channel boundaries, creating a need for further insights as to which modalities of AR could effectively facilitate the omnichannel customer experience. Future research could investigate the interactions between variables such as perceived value, satisfaction and purchase intention. Further research is needed on the AR attributes needed to deliver an

improved shopping experience (Poushneh and Vasquez-Parraga, 2017; Deloitte, 2020) and how AR increases consumer acquisition, loyalty and value (Chylinski *et al.*, 2020; Rauschnabel *et al.*, 2019; Jessen *et al.*, 2020). As the success of the AR retail experience depends on the product category (Yim *et al.*, 2017), future research could examine the most meaningful attributes in different product categories and market positions e.g. mass market and luxury. Further research on the negative aspects of AR could inform how perceived challenges may be overcome, such as privacy concerns (Hilken *et al.*, 2017; Rauschnabel *et al.*, 2018) which remain poorly understood (de Ruyter *et al.*, 2020). Shared or adaptive AR experiences, which enrich embedded or embodied interactions, are relatively neglected in existing studies (Chylinski *et al.*, 2020) but evident in practical use, as brands add experience-sharing innovations to their AR strategy to recreate social experiences that were missed during the pandemic (Papagiannis, 2020). Future research could explore value co-creation and word-of-mouth implications of synchronous and asynchronous shared AR experiences and communication between users, and how these shape consumer behaviour to inform an effective marketing strategy. Adaptive experiences that harness AI to adjust to consumers' needs without direct control offer greater personalisation but have implications for privacy concerns due to the data that needs to be collected (Chylinski *et al.*, 2020). Future research should address the ethical implications of adaptive AR experiences, for example the extent to which consumer data acquisition may result in privacy concerns, and how these may affect behavioural outcomes as well as the potential offloading of cognition as AR marketing technology advances, especially for vulnerable populations such as children or people with learning difficulties (Chylinski *et al.*, 2020).

Although commonly used, undergraduate student samples tend to limit the generalisability of findings (Baek *et al.*, 2018) and may not reflect the target consumer for certain product categories, such as furniture. Future research should seek a broader demographic of research participants or conduct field research with actual consumers. In particular, there is a lack of research on children, although in practice cereal brands are applying the educational potential of AR to engage with children (Galaria, 2020). More qualitative studies could build a deeper understanding of its advantages in retail environments and its real value (Dacko, 2017), while mixed methods studies could yield breadth and depth of evidence for theory generation and hypothesis testing. Given the internationalisation of retailing, cross-cultural research could build understanding of the cultural differences in consumer perceptions of AR's value in retail settings.

- *AR for digital entertainment and virtual clothing*

AR's hedonic benefits point to research opportunities on AR as a form of digital entertainment, especially as live events and product launches gave way to virtual ones during the pandemic, enabling attendees to be active participants rather than passive viewers (Galaria, 2020). As gradual easing of lockdown gives way to a new phenomenon of 'reopening anxiety', the continuing relevance of AR-enabled virtual events gives opportunities to extend AR research beyond products to events. The intersection of intersection of AR and gamification prompts research opportunities. Gamification is a promotional technique that applies 'game-like thinking' to non-gaming industries and has significant ramifications for how brands communicate with consumers, especially as consumers are spending more time online and at home. In 2021, Gucci launched an AR trainer to wear in photos on social media and in partnered mobile apps (Business of Fashion, 2021), leveraging digital entertainment and social gaming experiences to open

new markets and reach consumers (Papagiannis, 2020). As a potentially new class of digital products, AR holograms would benefit from further research on how they allow customers to communicate and share experiences (Carrozzi *et al.*, 2019; Heller *et al.*, 2019b; Hilken *et al.*, 2020). AR-enabled virtual clothing and footwear ('digital skins') have become hyper-realistic to appeal as products *per se*, not only as decision-making aids for physical products. This prompts future research to explore consumer sentiments around clothing designed to be worn online only (e.g. social media, virtual worlds) and whether the lack of physical ownership presents a viable alternative to fast fashion. The gaming/fashion crossover presents a novel research context as luxury brands develop designer 'digital skins' for gaming avatars, as does the context of esports with its spectator element.

6.2 Managerial implications

The value of AR to allow consumers to remotely try on, try out and interact with products translates into many positive marketing outcomes (Deloitte, 2020). Retailers need to re-think and adapt strategies to build on the acceptance and proven value of AR as an important component of the retail experience for broader demographics of consumers, not only digital natives, and capitalise on AR's ability to broaden the variety of virtual try-on and assessment options for various product categories beyond what would be possible in a physical capacity. Furthermore, retailers could explore the notion of AR as entertainment and a distinct class of digital products for sharing within-app or as AR holograms on social media (Hilken *et al.*, 2020; Carrozzi *et al.*, 2019; Heller *et al.*, 2019b;) to promote AR's social value proposition (Hilken *et al.*, 2020). Brands need to integrate AR into their omnichannel retail strategy across the purchase journey (Romano *et al.*, 2020) and communications channels (de Ruyter *et al.*, 2020; Yang *et al.*, 2020) to avoid

channel switching and churn from perceived channel limitations (Hilken *et al.*, 2020), and use social platforms to embed gamification in response to consumer desire for personalisation, self-expression and playfulness online, areas that the pandemic has accelerated. As physical stores reopen, AR could supplement the customer journey at home, in-store and on the move by creating experiences that support the brand ethos and are aligned to a customer-centric approach of enjoyment or informativeness about the brand and product (Holdack *et al.*, 2020). Careful consideration of the purpose and value of AR in retail is required to implement a meaningful omnichannel strategy that enhances customer experience and minimises negative outcomes of AR (Romano *et al.*, 2020) caused by technical limitations or low quality representation (Plotkina and Saurel, 2019) or contingency factors such as the user-value-versus-privacy tradeoff (Parise *et al.*, 2016).

7. Conclusions

The pandemic helped to prove the value proposition of AR for consumers and retailers. The acceleration of changes over the past year will no doubt influence and help shape future research to understand the short-term and long-term impact of the pandemic on AR adoption and evolution. A holistic view of the evolving advantages and challenges of AR provides opportunities, directions and avenues for future study, which will require various methods including both quantitative and qualitative inquiry, as well as further literature reviews to summarise and synthesise the empirical studies. Future research should follow AR's interdisciplinary nature and conduct research spanning both HCI and marketing/management traditions.

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