The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1066-2243.htm

Using augmented reality for shopping: a framework for AR induced consumer behavior, literature review and future agenda

Marc Riar
Faculty of Economics and Management, Technical University of Berlin, Berlin, Germany and
Faculty of Information Technology and Communication Sciences, Tampere University, Tampere, Finland
Nannan Xi
Faculty of Management and Business, Tampere University, Tampere, Finland and School of Technology and Innovations, University of Vaasa, Vaasa, Finland
Jakob J. Korbel and Ruediger Zarnekow
Faculty of Economics and Management, Technical University of Berlin, Berlin, Germany, and
Juho Hamari
Faculty of Information Technology and Communication Sciences, Tampere University, Tampere, Finland

Received 29 August 2021
Revised 19 November 2021
4 January 2022
23 February 2022
Accepted 27 February 2022

Abstract

Purpose – A current technological trend, which has gained even more traction recently due to the COVID-19 pandemic, is the use of augmented reality (AR) in shopping environments. AR is addressing contemporary challenges rooted in online shopping (e.g. in terms of experientiality and try-on) and is fundamentally reshaping consumers' experiences. The purpose of this study is to provide a synthesized and structured overview of the state-of-the-art research focused on AR shopping.

Design/methodology/approach – The authors conduct a systematic literature review of the empirical academic corpus focused on shopping via AR technology.

Findings – The review reveals the diverse psychological (cognitive, affective, and social) as well as behavioral outcomes related to the use of AR in the shopping context. The authors integrate the results into a framework for AR induced consumer behavior in shopping, thereby providing an important overview of the dynamics in AR-related shopping and the factors influencing the adoption of the technology by consumers. Specifically, the authors encountered that the technological abilities of AR (e.g. in terms of interactivity, vividness, informativeness, etc.) are a source for enhanced utilitarian and hedonic shopping experiences that can support intentions to purchase a product, reuse an AR app, or recommend it to others. Importantly, our review reveals the demand for several avenues for future research.

Originality/value – The authors provide an overview and synthesis of how and where AR is employed in shopping contexts, what theories and technological characteristics of AR are commonly analyzed, and what psychological and behavioral outcomes AR has been found to evoke. Based on our findings, the authors derive a framework that illustrates the dynamics in AR shopping and give an in-depth discourse on 13 future research agenda points related to thematic, theoretical, methodological, and technological matters.

Keywords Augmented reality (AR), Shopping, Consumer behavior, E-commerce, Retail, 3D product presentation, Metaverse

Paper type Research paper

Funding: This work has been supported by Liikesivistysrahasto under Grant No. 210301; the Academy of Finland under Grant No. 327241 and Grant No. 337653.

1066-2243
DOI 10.1108/INTR-08-2021-0611

1. Introduction

With the development of information technology, there has been a technological revolution in business and marketing, and this is especially true for shopping contexts. Starting from around the year 1990, E-Commerce, which refers to conducting commerce electronically, has become an indispensable practice for companies and it has been believed to have more advantages than shopping in brick-and-mortar stores, especially in terms of convenience as well as economic, time, and physical cost. As a consequence, consumers are getting used to and increasingly rely on online shopping services (Perea y Monsuwé *et al.*, 2004). Nevertheless, traditional web-based online shops still have limitations in terms of product presentation, product trial, information richness, and multidimensional experientiality. For example, when assessing large furniture, complex machines, and especially products with high economic value, consumers often end up going to physical stores to acquire a more multifaceted understanding of the product. The other more common example is related to try-on experience. Without trying, consumers may find it challenging to evaluate the values of products such as clothing, glasses, and accessories, which are mainly purchased for self-presentation. In consequence, practitioners are looking for ways to address and resolve these shopping dilemmas. The popularity of mobile devices and the advent of immersive technologies such as augmented reality (AR) are believed to provide new opportunities for increasing interactivity (Huang and Liao, 2017), richness and vividness of information (Yim *et al.*, 2017), personalized experience (Smink *et al.*, 2020) and place independency of retail. Extended reality (XR) is the umbrella term used for virtual reality (VR) and AR. Whereas VR refers to substituting the perceived reality (Xi and Hamari, 2021), AR refers to augmenting the perceived reality (Carmigniani *et al.*, 2011; Rauschnabel, 2021). AR allows digital sensory information to be incorporated into the user experience in real-time through different mediums (visual display, e.g. smartphones, tablets, glasses; sound, smell, and touch displays). Today's advanced AR wearables facilitate and optimize consumers' shopping experiences via hands-free, fast response, and rich interaction. Currently, large international retail companies such as IKEA, Walmart, and Amazon have developed their own AR services to supplement the current retail activities, such as IKEA Place for 3D product display, Walmart AR scanning tool for product comparison, and Amazon AR View for product trial. Especially due to the COVID-19 pandemic, the consumers' need for AR shopping has been spiking and AR has the potential to be highly disruptive in marketing (Rauschnabel, 2021).

However, retailers and business practitioners still seem hesitant to adopt the technology, which, among other factors, has to do with uncertainties about the potential of AR (e.g. in terms of performance) as well as whether and how consumers accept the technology for shopping. For example, retailers are skeptical of the purchase conversion rate that can be achieved by AR-mediated shopping due to the lack of overview of empirical research and practical evidence. The dynamics between the economic and time cost of developing AR stores, marketing, and sales performance, continuous use, and customer loyalty are still unclear (Huang and Liao, 2015; Qin *et al.*, 2021a). Moreover, consumers may be concerned about privacy risks since they usually are required to present and expose their face, fingers, hands, or bodies in front of the cameras and they may perceive the risk of being tracked in location-based AR applications that require GPS service (Cowan *et al.*, 2021; Lele and Shaw, 2021; Rauschnabel *et al.*, 2018). The perceived loss of autonomy and the fear of being controlled might lead to a decrease in consumers' adoption of self-service technology such as AR (Rauschnabel *et al.*, 2018). Ultimately, the aspects that either inhibit or drive consumers' willingness to use AR for shopping are often intangible for practitioners. Therefore, as of yet, it is still unclear whether AR can provide inferior or superior consumer experience in both online and offline shopping environments, as well as what factors play into the adoption of AR among consumers.

The purpose of this paper is to synthesize the current empirical literature on AR in the context of shopping in order to investigate how and where AR has been employed in shopping contexts and what is known about the effects and criteria for adoption of the technology. Moreover, to move the field forward from a research perspective, we seek to structure the theoretical perspectives that have so far governed investigations into AR shopping and to derive potential directions for future research. This study is organized as follows. First, the concept and features of AR are presented in the background section and a general scheme for AR shopping is conceptualized (Section 2). The methodology section presents the search strategy, procedure, and literature identification (Section 3). The analysis of the retrieved literature is described according to the encountered shopping environments, devices, product categories, employed theories, technology characteristics as well as psychological and behavioral outcomes (Section 4). We then move to the discussion of our results by deriving a framework for AR induced consumer behavior in shopping and by providing theoretical (Section 5.1) and practical implications (Section 5.2). Moreover, based on the main findings of our review, we derive 13 future research avenues pertaining to thematic, theoretical, methodological, and technological matters (Section 5.3). The last section presents the conclusion and limitations of this study (Section 6).

2. Background

As one important segment of virtual technologies, for a long time, AR has been considered as an interchangeable term for VR. On some occasions in the literature the term "augmented reality/AR" is used even though studies relate to VR or other topics. Another early view considered AR as a growing area in the VR sphere, such as AR is a variant of immersive VR simulations (Pilote and Chiniara, 2019) and AR is a branch of VR (Chen *et al.*, 2016; Huang *et al.*, 2011; Pengcheng *et al.*, 2011). Importantly, Flavián *et al.* (2019) contribute to a better understanding of the boundaries of immersive technologies based on a taxonomy that considers the technological embodiment, psychological presence, and the perspective of interactivity. In addition, Xi and Hamari (2021) proposed an accurate definition for VR, which represents the technologies for substituting the perceived reality. It can be seen that the objectives of applying AR and VR are different: AR aims at modifying the current world we can perceive while VR aims at replacing it. Galar and Kumar (2017) characterize AR in a nutshell as: reality is still there, but it is augmented or enhanced in some way.

The more common view states that AR is about superimposing digital information onto our view of the real world (Ley, 2010). The most typical augmented information is visual information such as texts, videos, and 3D objects (Cheng and Tsai, 2014; McLean and Wilson, 2019; Yip *et al.*, 2019). Azuma (1997) proposed the definition of AR based on three characteristics: a combination of real and virtual elements, real-time interactivity, and 3D content. Therefore, many studies have referred to a rather narrow view on AR that its function consists in providing stereoscopic vision experience facilitated by near-eye displays such as mobile phones, tablets, glasses, and headsets. However, it should be realized that any form of sensory information (e.g. vision, sound, touch, smell, and movement) can be augmented in a digital way (van Krevelen and Poelman, 2010). It should also be noted that the perceived VR can be augmented by similarly superimposing other content onto it. The term "augmented virtuality (AV)" has been used to describe the augmentation of VR (Albert *et al.*, 2014). Generally speaking, AR technology has garnered large attention in the past decade and has been investigated in contexts such as education (Wu *et al.*, 2013), in the workplace (Masood and Egger, 2019), phobia treatment (Tabbakh *et al.*, 2015), as well as in countless leisure applications, perhaps most considerably in games (Hamari *et al.*, 2019; Laato *et al.*, 2020; Morschheuser *et al.*, 2017; Riar *et al.*, 2020). In shopping-related contexts, AR has been investigated in online web shopping settings, in-store and mobile shopping apps (Caboni and

Hagberg, 2019; Riar *et al.*, 2021). However, so far, we lack a full understanding in terms of which of these domains are the most promising to employ AR technology, what products are usually investigated, and what theories are used to investigate AR in shopping scenarios. Importantly, we lack an overarching understanding of the effects and most relevant adoption criteria of AR technology in the shopping context. The effects of AR are commonly conceptualized as technology characteristics influencing the psychological outcomes of users, which essentially affect the behavioral outcomes (Kowalczuk *et al.*, 2021) (see Figure 1). We adopt this notion and specifically focus in our review on how the technological proficiencies of AR influence the psychological and behavioral outcomes of consumers. Based on the gathered knowledge on these and related issues from the state-of-the-art literature, we provide a discourse on potential future research avenues for AR-mediated shopping.

3. Methodology

The methodology of this paper is guided by recommendations for conducting systematic literature reviews by Kitchenham (2004) and Brereton *et al.* (2007). Based on these guidelines, we describe the search strategy, the study selection process, and means of data extraction from the identified studies.

3.1 Search strategy

First, the bibliographic sources for the preliminary search were selected. In correspondence with Brereton *et al.* (2007), we targeted different databases to ensure an exhaustive search of the literature. To cover a great spectrum of interdisciplinary fields, we selected the two databases Web of Science and the Association for Information Systems Electronic Library (AISeL) since both index additional bibliographic databases, i.e. ACM Digital Library and IEEE Xplore. In addition, the databases are highly recognized in the field of information systems and human-computer interaction research. In turn, they seem adequate for the scope of this study, i.e. to study the outcomes and adoption of AR in the context of shopping.

Second, key terms for the search query were selected. Next to the core search terms ("augmented reality" and "shopping"), we included several variations of these terms and used asterisk (*) to comprise varying terminology in the literature (e.g. "retail", "commerce" and "business", in addition to shopping, and "AR" for augmented reality). The preliminary search revealed that several studies refer to the term "virtual try-on" in relation to the application of AR in shopping. Hence the term was added to the initial search string, resulting in the search query:

("augmented reality" OR AR OR "virtual try-on") AND

(shop* OR retail* OR commerce OR business)

Third, the composed search query was used to perform the preliminary search in the two selected databases in April 2021. The search was limited to the title, abstract, and keywords (Web of Science)/subject (AISeL) of the publications. To test the appropriateness of the search query, we identified several relevant publications manually and tested whether the studies were existent in the search results. In this process, all manually selected publications could be found in the sample. Hence, the search query seems appropriate.

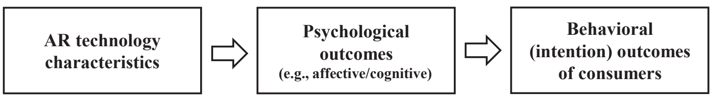


Figure 1. Conceptualization of AR shopping

3.2 Study selection

The study selection process is conducted in three phases and is illustrated in Figure 2. In the first phase, studies were identified based on a preliminary search. The preliminary search in the databases Web of Science (n = 617) and AISeL (n = 61) revealed 678 publications. A pre-screening of the sample set resulted in the exclusion of duplicates (1), publications in a language other than English (5), and studies that we were not able to access and did not receive after personally contacting the authors (10). The remaining 662 publications were examined and evaluated based on inclusion criteria in the second phase of the study selection process.

In the second phase, the inclusion criteria for the publications were set and applied to the remaining publications. Since the scope of the study is AR in the context of shopping, publications focusing on other settings were excluded. Furthermore, the aim of the study is to analyze the outcomes and factors that influence AR adoption. Hence, only publications of empirical inferential nature (e.g. experiments, structural equation modeling, etc.) were included. In turn, all publications that rely on other methodological approaches, such as pure design or case studies, were excluded if they did not conduct any empirical analysis. The sample set contained several publications that do not concern AR but VR. Although both technologies show certain similarities, the objective of this study is to examine AR based approaches. Thus, all studies that analyze the deployment of VR in shopping were excluded. Exceptions were made for publications that addressed both AR and VR. These publications remained in the sample but only the results concerning AR were included in the synthesis and analysis of the publications. In addition, we only considered literature from January 2010 to March 2021. The exclusion of publications before 2010 was deemed necessary due to the technological developments in the field of AR. In the past decade, the experience of using AR considerably changed due to the maturity and diffusion of the technology which can be expected to affect the adoption of the technology. Lastly, we only considered publications that are peer reviewed, i.e. journals, conference proceedings, and book chapters. Hence, we excluded all articles that did not undergo a peer review process. In a first step, the inclusion criteria were applied to the title and abstracts of the publication and in some uncertain cases, we viewed the method and discussion section, leading to the exclusion of 594 studies. In a second step, the full texts of the remaining 68 articles were examined and the above-described inclusion criteria were applied. This process resulted in the exclusion of another 35 publications. Hence, 33 studies were selected for the last phase of the study selection process.

In the third phase, we conducted a forward and backward search. Based on the references in the identified publications and papers that referenced these studies, we identified five

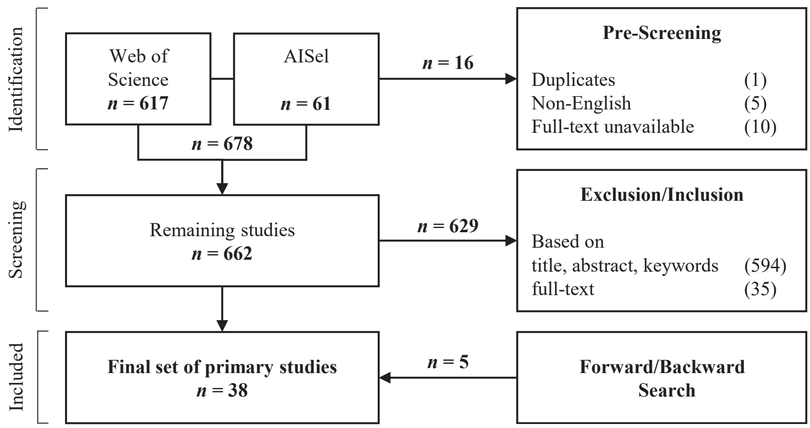
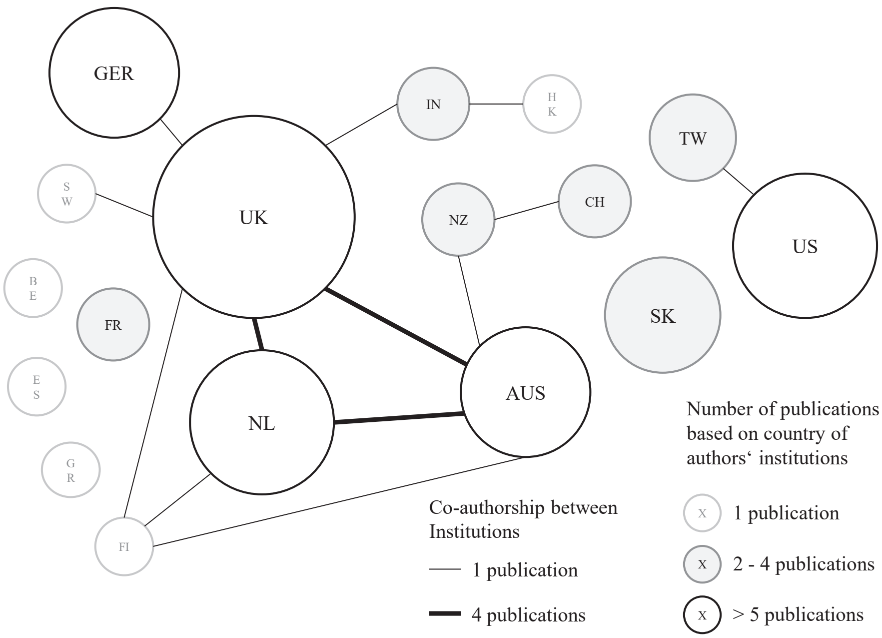


Figure 2.
Study selection process

additional studies that were included in our sample. The final set of primary studies includes 38 publications. In Figure 3, an illustration of the origin of the primary studies (authors' affiliation by countries) is provided.

3.3 Data extraction

The data extraction is based on the recommendations of Kitchenham (2004) and Brereton *et al.* (2007). Two researchers of the present paper have been involved in the literature screening and data extraction process. First, we jointly prepared a data extraction form that consists of several publication details, i.e. title, author, year of publication, abstract, publication outlet, etc., and relevant properties, i.e. research design, theoretical concepts, how and in what setting AR is employed, and in accordance with our conceptualization of AR shopping (see Figure 1), what technological characteristics were investigated, and what psychological and behavioral outcomes were reported in the analyzed studies. The data extraction form serves the purpose of aggregating and arranging all relevant information in a coherent and organized manner. Second, we tested the comprehensiveness of our data extraction form by selecting three publications from our final dataset randomly and by independently extracting the relevant information. We then compared and discussed the extracted information. Based on this initial test set, we made minor adjustments to the data extraction form. The resulting data extraction form was deemed suitable for extracting the relevant information in a well-structured process. Both researchers independently extracted the data from a subset of the included body of literature. Later, we cross-checked each other's work and any disagreements have been discussed by consulting with the other authors of the



AUS: Australia ES: Spain GER: Germany IN: India SK: South Korea UK: United Kingdom
BE: Belgium FI: Finland GR: Greece NL: Netherlands SW: Sweden US: United States
CH: China FR: France HK: Hong Kong NZ: New Zealand TW: Taiwan

Figure 3.
Overview of authors' affiliation by country

present paper. There have been only a few minor disagreements that had to do with whether we aggregate certain concepts under an umbrella term (e.g. theoretical concepts). However, we decided to be as detailed as possible with all extracted information and the extraction form otherwise did not leave much room for alternative interpretations during data collection because the extracted values were unequivocal rather than prone to subjective judgments (e.g. the values of interest such as the theoretical concepts that have been employed in the studies, the technological attributes of AR, the psychological and behavioral outcomes, etc., are clearly identifiable and do not leave room for subjective judgments). In the end, the explicit values in the extraction form as well as the cross-checking of each other's work and the discussions led to a coherent set of extracted data. Thus, we did not perform additional interrater reliability tests to assess variations in the coding of the data.

4. Results

Our search considers the empirical literature on AR in shopping published between January 2010 and March 2021. Table 1 reveals the publication venues of the reviewed studies, indicating that AR research in the shopping context has traversed into outlets with versatile and multidisciplinary focus, such as E-Commerce, interactive marketing, psychology, human-computer interaction, etc. As illustrated in Table 2 and Figure 4, the empirical literature on AR in retail has been rather unassuming between the years 2010 and 2016. Arguably, this has to do with the circumstance that research in this timeframe still has been more preoccupied with exploring the technological developments of AR. Only since 2017 did empirical research on AR for the purpose of shopping take off considerably. Especially in more recent years, the topic has taken a substantial foothold in research with an observable upwards trend since 2018 (for the year 2021 literature is only considered until March and it can be presumed that this trend will rise further). This comes to show that the topic surrounding the use of AR technology in shopping is becoming increasingly relevant.

4.1 In what shopping environments is AR used?

As indicated in Table 3, AR is mostly examined for the purpose of online shopping within the set of identified primary studies (in 73.7%). The main advantage of using AR technology in online shopping environments is to present consumers with similar or sometimes even more unique product experiences and information as in physical stores. Essentially, AR solutions for online shopping have the main advantage that the consumers can try out products virtually, to which they currently do not have physical access. For example, users can virtually place products directly in their homes and experience them in their intended surroundings to get a better idea of the product features before making purchase decisions (e.g. Adam and Pecorelli, 2018; Brengman *et al.*, 2019; Choi and Choi, 2020; Fan *et al.*, 2020; Haile and Kang, 2020; Kowalczuk *et al.*, 2021; Lu and Smith, 2010; Pantano *et al.*, 2017). In addition to investigating online solutions, 13.2% of the analyzed studies explored the use of AR in physical stores. AR has been applied in physical stores to offer users virtual try-on possibilities or to provide additional product information. Among other advantages, such in-store solutions can attract the attention of consumers, raise curiosity, make the shopping experience more convenient, playful, and satisfying (e.g. Javornik *et al.*, 2016).

4.2 What devices are used?

As revealed in Table 4, the screened literature mostly employed hand-based mobile devices, such as mobile phones and tablets to analyze the effects of AR for shopping purposes (68.4%), whereas several studies also examined the effects of AR via desktop PCs (21.1%), often in combination with web cameras. The popularity of mobile devices (compared to, say, desktop

Table 1.
Overview of the publication venues

Venue/outlet	Studies	#	%
Journal of Retailing and Consumer Services	Beck and Crié (2018), Bonnin (2020), Fan *et al.* (2020), Huang (2019), Pantano *et al.* (2017), Park and Yoo (2020), Poushneh (2018), Poushneh and Vasquez-Parraga (2017), Qin *et al.* (2021b), van Esch *et al.* (2019)	10	26.3
Journal of Business Research	Jessen *et al.* (2020), Kowalczuk *et al.* (2021), Smink *et al.* (2020)	3	7.9
Journal of Retailing	Heller *et al.* (2019a, b)	2	5.3
Journal of the Academy of Marketing Science	Hilken *et al.* (2017, 2020)	2	5.3
Technological Forecasting and Social Change	Dacko (2017), Rese *et al.* (2017)	2	5.3
ACM Conference on Designing Interactive Systems	Javornik *et al.* (2016)	1	2.6
Computers in Human Behavior	McLean and Wilson (2019)	1	2.6
Cyberpsychology, Behavior, and Social Networking	Choi and Choi (2020)	1	2.6
Electronic Commerce Research	Huang and Liao (2015)	1	2.6
Electronic Commerce Research and Applications	Smink *et al.* (2019)	1	2.6
European Conference on Information Systems	Adam and Pecorelli (2018)	1	2.6
Informatics	Yoo (2020)	1	2.6
International Conference on Information Systems	Tarafdar *et al.* (2019)	1	2.6
Internet Research	Zhang *et al.* (2019)	1	2.6
Journal of Computing and Information Science in Engineering	Lu and Smith (2010)	1	2.6
Journal of Interactive Marketing	Yim *et al.* (2017)	1	2.6
Journal of Marketing Management	Javornik (2016)	1	2.6
Journal of Strategic Marketing	Moriuchi *et al.* (2020)	1	2.6
Journal of Theoretical and Applied Electronic Commerce Research	Saprikis *et al.* (2021)	1	2.6
Multimedia Systems	Morillo *et al.* (2019)	1	2.6
Psychology and Marketing	Mishra *et al.* (2021)	1	2.6
SOP Transactions on Marketing Research	Spreer and Kallweit (2014)	1	2.6
Sustainability	Haile and Kang (2020)	1	2.6
Virtual Reality	Brengman *et al.* (2019)	1	2.6
Sum		38	100

PCs) can be attributed to their maneuverability, which unleashes greater potentials of AR technology, as one of the core advantages of it consists not only in its ability to superimpose virtual objects in a room but also to move and manipulate them via movement-based controls. Therefore, it seems plausible that mobile devices have been the most popular choice to investigate the effects of AR for shopping purposes. Some of the AR solutions involve the concept of virtual (or "magic") mirrors, by which users can view themselves and virtually try on, for example, eyewear (Beck and Crié, 2018; Hilken *et al.*, 2017; Pantano *et al.*, 2017), makeup (Hilken *et al.*, 2017; Javornik, 2016) or other fashion-related products (Beck and Crié, 2018). This feature can be implemented via both mobile devices (e.g. by using the built-in cameras) and desktop PCs (e.g. by using web cameras). Surprisingly, we encountered only one study which examined respective AR hardware (i.e. HoloLens) (Heller *et al.*, 2019b), while there was also a unique encounter in which one study investigated product presentation via a pseudo-

Year	Studies	#	%
2010–2016	Huang and Liao (2015), Javornik (2016), Javornik *et al.* (2016), Lu and Smith (2010), Spreer and Kallweit (2014)	5	13.2
2017	Dacko (2017), Hilken *et al.* (2017), Pantano *et al.* (2017), Poushneh and Vasquez-Parraga (2017), Rese *et al.* (2017), Yim *et al.* (2017)	6	15.8
2018	Adam and Pecorelli (2018), Beck and Crié (2018), Poushneh (2018)	3	7.9
2019	Brengman *et al.* (2019), Heller *et al.* (2019a, b), Huang (2019), McLean and Wilson (2019), Morillo *et al.* (2019), Smink *et al.* (2019), Tarafdar *et al.* (2019), van Esch *et al.* (2019), Zhang *et al.* (2019)	10	26.3
2020	Bonnin (2020), Choi and Choi (2020), Fan *et al.* (2020), Haile and Kang (2020), Hilken *et al.* (2020), Jessen *et al.* (2020), Moriuchi *et al.* (2020), Park and Yoo (2020), Smink *et al.* (2020), Yoo (2020)	10	26.3
March 2021	Kowalczuk *et al.* (2021), Mishra *et al.* (2021), Qin *et al.* (2021b), Saprikis *et al.* (2021)	4	10.5
Sum		38	100

Table 2. Overview of the primary studies and their publication year

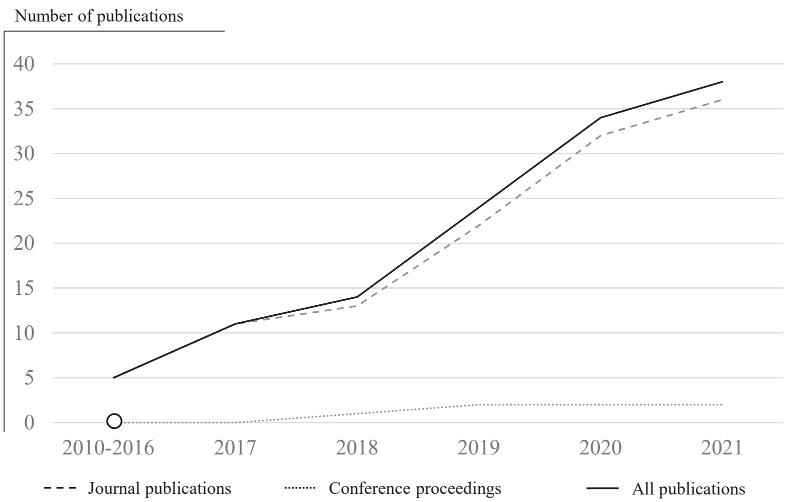


Figure 4. Number of publications cumulated by year

Environment	Studies	#	%
Online web-based	Adam and Pecorelli (2018), Beck and Crié (2018), Bonnin (2020), Brengman *et al.* (2019), Choi and Choi (2020), Fan *et al.* (2020), Haile and Kang (2020), Heller *et al.* (2019a, b), Hilken *et al.* (2017, 2020), Huang (2019), Huang and Liao (2015), Javornik (2016), Jessen *et al.* (2020), Kowalczuk *et al.* (2021), Lu and Smith (2010), Mishra *et al.* (2021), Pantano *et al.* (2017), Park and Yoo (2020), Poushneh and Vasquez-Parraga (2017), Qin *et al.* (2021b), Smink *et al.* (2019), Smink *et al.* (2020), Tarafdar *et al.* (2019), Yim *et al.* (2017), Yoo (2020), Zhang *et al.* (2019)	28	73.7
Various/non-specific	Dacko (2017), McLean and Wilson (2019), Moriuchi *et al.* (2020), Poushneh (2018), Rese *et al.* (2017), Saprikis *et al.* (2021)	6	15.8
In-store	Heller *et al.* (2019a), Javornik *et al.* (2016), Morillo *et al.* (2019), Spreer and Kallweit (2014), van Esch *et al.* (2019)	5	13.2

Table 3. Overview of the examined shopping environments

Table 4.
Overview of the investigated devices

Devices	Studies	#	%
Hand-based mobile devices (e.g. phone, tablet)	Brengman *et al.* (2019), Choi and Choi (2020), Dacko (2017), Fan *et al.* (2020), Haile and Kang (2020), Heller *et al.* (2019a), Hilken *et al.* (2020), Javornik (2016), Javornik *et al.* (2016), Jessen *et al.* (2020), Kowalczuk *et al.* (2021), McLean and Wilson (2019), Mishra *et al.* (2021), Morillo *et al.* (2019), Moriuchi *et al.* (2020), Park and Yoo (2020), Poushneh (2018), Qin *et al.* (2021b), Rese *et al.* (2017), Saprikis *et al.* (2021), Smink *et al.* (2019), Smink *et al.* (2020), Spreer and Kallweit (2014), Tarafdar *et al.* (2019), van Esch *et al.* (2019), Yoo (2020)	26	68.4
Desktop PC (e.g. with web camera)	Adam and Pecorelli (2018), Bonnin (2020), Hilken *et al.* (2017), Huang (2019), Lu and Smith (2010), Pantano *et al.* (2017), Poushneh and Vasquez-Parraga (2017), Yim *et al.* (2017)	8	21.1
General/Non-specific	Beck and Crié (2018), Huang and Liao (2015), Zhang *et al.* (2019)	3	7.9
Head-based AR hardware	Heller *et al.* (2019b)	1	2.6
Pseudo-holographic stereogram	Morillo *et al.* (2019)	1	2.6

holographic stereogram (i.e. Morillo *et al.*, 2019). However, the pervasiveness of mobile devices and the fact that they are increasingly equipped and rolled out with built-in AR features, whereas AR hardware is hardly at our fingertips since it has not yet penetrated into regular households, it is apprehensible that the majority of the screened literature examined AR via more ubiquitous devices, such as tablets and smartphones. In addition, mobile devices have further advantages, for example, in terms of convenience, economic value, and lower costs for developing AR features compared to special AR hardware. Thus, it seems safe to assume that mobile devices will continue to be the main focus for AR technology, at least in the next few years. Nevertheless, specific AR hardware will also become more and more affordable, and accordingly, it seems important that such devices are more often included in future research.

4.3 What products are presented in AR retail?

As indicated in Table 5, we encountered that furniture and decoration products were the most analyzed types of products in the reviewed body of literature (in 44.7% of studies). Via AR technology, furniture (e.g. chairs, sofas, tables, closets, etc.) and decoration products (e.g. wall hangings, plants, wall colors, etc.) can be experienced in their intended environment so that potential buyers can get a better idea of what the products and their features (e.g. size, color, shape) will look like in their homes, offices, or other surroundings. The second and third most encountered types of products have been fashion-related (in 36.8% of studies) and cosmetics (in 23.7% of studies). Instead of superimposing products into a room, these types of products can often be experienced directly on oneself via virtual/magic mirrors (e.g. Beck and Crié, 2018; Javornik, 2016; Pantano *et al.*, 2017; Poushneh, 2018). This means that via AR technology, consumers can view themselves as if looking into a mirror and virtually apply makeup or try on fashion products (e.g. eyewear, clothes, watches, etc.). An obvious benefit, as with other products, is that AR can help give consumers a better idea of products if they are currently not physically available (i.e. during online shopping), which can support purchase decisions. If used in a physical store, individuals can get an initial idea of what these products would look like on themselves by trying these out virtually instead of physically. This can save time and provides the convenience of not having to switch clothes or having to apply different sorts and colors of makeup to make an initial evaluation of products. Arguably, this

Products	Studies	#	%
Furniture, decorations	Adam and Pecorelli (2018), Brengman *et al.* (2019), Choi and Choi (2020), Haile and Kang (2020), Heller *et al.* (2019a, b), Hilken *et al.* (2017), Javornik (2016), Jessen *et al.* (2020), Kowalczuk *et al.* (2021), Lu and Smith (2010), Mishra *et al.* (2021), Poushneh (2018), Qin *et al.* (2021b), Rese *et al.* (2017), Smink *et al.* (2020), Tarafdar *et al.* (2019)	17	44.7
Clothing, fashion, accessories, eyewear	Beck and Crié (2018), Bonnin (2020), Hilken *et al.* (2017), Huang (2019), Huang and Liao (2015), Morillo *et al.* (2019), Moriuchi *et al.* (2020), Pantano *et al.* (2017), Poushneh (2018), Poushneh and Vasquez-Parraga (2017), Qin *et al.* (2021b), Rese *et al.* (2017), Yim *et al.* (2017), Zhang *et al.* (2019)	14	36.8
Makeup, cosmetics	Fan *et al.* (2020), Hilken *et al.* (2017), Javornik (2016), Javornik *et al.* (2016), Moriuchi *et al.* (2020), Park and Yoo (2020), Smink *et al.* (2019), Smink *et al.* (2020), Yoo (2020)	9	23.7
Various/non-specific	Dacko (2017), McLean and Wilson (2019), Poushneh (2018), Saprikis *et al.* (2021)	4	10.5
Food	Heller *et al.* (2019a), van Esch *et al.* (2019)	2	5.3
Technology-related devices	Fan *et al.* (2020), Tarafdar *et al.* (2019)	2	5.3
Books	Spreer and Kallweit (2014)	1	2.6
Cars	Rese *et al.* (2017)	1	2.6

Note(s): The study by Hilken *et al.* (2020) does not appear in this table because it focuses on investigating a feature (i.e. changing wall colors via AR) rather than on investigating a particular product

Table 5. Overview of the types of virtual products

does not entirely replace the experience of actually trying on the physical products, however, it can be a good method for consumers to save time and narrow down their choices before opting to try out the physical products.

As revealed further in Table 5, there have also been more unique encounters in the reviewed studies in terms of the analyzed products, such as food products (Heller *et al.*, 2019a; van Esch *et al.*, 2019), cars (Rese *et al.*, 2017), books (Spreer and Kallweit, 2014) and technology-related products (e.g. laptops and printers) (Fan *et al.*, 2020; Tarafdar *et al.*, 2019). It is especially notable that compared to low-complexity products, such as clothing, eyewear, furniture, etc., products of higher complexity, such as technology products, remain unassuming in the reviewed literature. Products of high complexity generally entail a larger number and more complicated key features that demand more of both, the user in terms of processing the information as well as from the AR solution, in terms of providing a satisfactory representation of the products in all their complexity. Moreover, high complexity products also require more effort, time, and attention to detail when mapping them into virtual interactive 3D objects, which may explain why there has been less research on these types of products. Nevertheless, with the increasing maturity of AR technology and the fact that the processes to map even complicated products as virtual 3D objects is becoming more and more streamline, it seems important that research closes in on these technological advancements by investigating how well AR can support purchase decisions of consumers for even more complex products.

4.4 What theories are employed?

The reviewed literature draws on a variety of theories to explain the adoption and effects of AR technology. Altogether, we encountered 26 theories and concepts. We categorized these into consumer experience and acceptance theories (see Table 6) as well as cognitive theories (see Table 7).

Background, concepts, theories	Explanation	Adaptation in the AR shopping literature	Studies	#	%
Technology Acceptance Theory (TAM)	The TAM (Davis, 1989) explains how technology is adopted based on the formation of attitudes through perceived ease of use and usefulness	This theory has been the by far most extensively used in the reviewed studies to explain the adoption of AR for shopping (in 23.7% of studies) based on the perceived ease of use and usefulness of AR shopping solutions	Huang and Liao (2015), McLean and Wilson (2019), Pantano *et al.* (2017), Park and Yoo (2020), Qin *et al.* (2021b), Rese *et al.* (2017), Saprikis *et al.* (2021), Spreer and Kallweit (2014)	8	21.1
Consumer acceptance, engagement and motivation	Consumer acceptance or brand engagement are overarching considerations of organizations by which they seek to understand the multidimensional determinants that draw customers to their brand	Several studies investigate AR shopping under the generic umbrella of customer engagement and motivation, with the multidimensional determinants being of, e.g. cognitive, affective, social nature	Beck and Crié (2018), Brengman *et al.* (2019), Jessen *et al.* (2020), McLean and Wilson (2019)	4	10.5
Equity theory/ privacy calculus theory	Both equity theory (Adams, 1963) and privacy calculus theory (Dinev and Hart, 2006) suggest that decisions of individuals are based on rational judgments by weighing, e.g. expected input and output or benefits and effort/risks	These theories have been applied in the analyzed studies based on the premise that customers will decide to use AR technology if they perceive that the output (i.e. the benefits) of doing so will outweigh the input or costs (e.g. sharing personal information, intrusiveness, etc.)	Poushneh (2018), Poushneh and Vasquez-Parraga (2017), Smink *et al.* (2019)	3	7.9
Unified Theory of Acceptance and Use of Technologies (UTAUT/ UTAUT2)	The UTAUT/UTAUT2 (Venkatesh *et al.*, 2012) is a model, which attempts to provide a uniform view of the determinants for technology adoption	Similar to the TAM, the UTAUT/UTAUT2 has been employed in the reviewed literature to explain the adoption of AR in shopping from a technology acceptance (e.g. utilitarian and hedonic) perspective	McLean and Wilson (2019), Saprikis *et al.* (2021)	2	5.3
Uses and gratifications theory	Uses and gratifications theory (Katz *et al.*, 1973) is based on the notion that individuals use certain media to satisfy specific needs	Uses and gratifications theory was employed to study how AR addresses utilitarian and hedonic need satisfaction, which is argued to translate into, e.g. purchase intentions	Kowalczuk *et al.* (2021), Zhang *et al.* (2019)	2	5.3

Table 6.
Overview of consumer experience and acceptance theories

(*continued*)

Background, concepts, theories	Explanation	Adaptation in the AR shopping literature	Studies	#	%
Experience economy theory	Experience economy theory (Pine and Gilmore, 1998) posits that the experience, resulting from compelling and memorable interaction with a product can become a value proposition for customers	AR has been investigated with the premise that the technology can produce compelling and memorable interaction with products, thus providing experiential value and supporting purchase intentions	Choi and Choi (2020)	1	2.6
Feelings-as information theory	According to feelings-as information theory (Schwarz, 2012), the affective responses of individuals can serve as information to make judgments and form beliefs	The theory has been applied to explain how product affinity and confidence in choice can emerge in an AR shopping context	Kowalczuk *et al.* (2021)	1	2.6
Habituation–tedium theory	The habituation-tedium theory (Sawyer, 1982) suggests that positively perceived novelty effects disappear with increasing familiarity (habituation) with stimuli, thereby transforming the positive perceptions progressively into neutral or negative perceptions (tedium)	This theory has been used in the reviewed literature to explain how greater levels of experience with AR can result in a decline of the perceived novelty of the technology	Yim *et al.* (2017)	1	2.6
Information richness theory	The main understanding of information richness theory (Daft and Lengel, 1986) is that the uncertainty of individuals can be reduced and understanding can be supported through large amounts (richness) of information	Given that AR is presumed to effectively inform customers during shopping via rich product presentations and interaction capabilities, it was investigated how the obtained informativeness affects attitudes towards AR	Qin *et al.* (2021b)	1	2.6

(*continued*)

Table 6.

Background, concepts, theories	Explanation	Adaptation in the AR shopping literature	Studies	#	%
Partially observance markov decision process (POMDP)	POMDP (Krishnamurthy, 2016) is a concept that aims to model decision processes that explain the interaction between humans and computers with the assumption that action effects are highly uncertain	Based on the consideration that users of AR are often not sure what to expect from using the technology (e.g. in terms of the outcomes of certain movements or what feedback will be provided), the concept of POMDP has been applied to AR in a shopping context to explore how attitudes towards AR may be formed	Moriuchi *et al.* (2020)	1	2.6
Task-media-fit theory	Task-media-fit theory (Mennecke *et al.*, 2000) proposes that technology must be designed in a way to provide efficacious opportunities for users to perform the task at hand. For example, if technology provides overly rich functionality, it may have too many distractions for users to perform tasks properly, whereas if it lacks, for instance, richness of information, it may impede users to successfully perform tasks	Drawing on this theorization, it was investigated if AR for shopping purposes is perceived differently for contrasting types of products (i.e. experience products vs search products)	Choi and Choi (2020)	1	2.6
Typology of experiential value	Rooted in consumer research, this typology consists of intrinsic and extrinsic determinants to explain the experienced value	This typology was used as a conceptualization for the intrinsic (i.e. playfulness and aesthetics) and extrinsic (i.e. consumer return on investment and service excellence) experiential value provided by AR during shopping	Dacko (2017)	1	2.6

Table 6.

Most considerably, the *Technology Acceptance Model* (TAM) was used as a theory to explain the adoption of AR technology for shopping (in 21.1% of studies). The TAM is a well-established theory; however, it is also fairly limited in terms of the considered determinants to predict the acceptance of information systems. The *Unified Theory of Acceptance and Use of Technologies* (UTAUT/UTAU2) builds on the considerations of the TAM and was developed in an attempt to provide a more comprehensive set of adoption factors for information

Background, concepts, theories	Explanation	Adaptation in the AR shopping literature	Studies	#	%
(Socially) situated cognition theory	Situated cognition theory (Brown *et al.*, 1989) understands that information processing is highly dependent on environmental conditions to which an individual is currently exposed to and socially situated cognition (Semin and Smith, 2013) refers to the influence that others have on an individual's cognitive processing of the environment	This theory played a role in explaining how AR affects cognitive processing based on the situational condition it creates (e.g. real-time interaction with products or point of view sharing)	Fan *et al.* (2020), Hilken *et al.* (2017), Hilken *et al.* (2020)	3	7.9
Theory of vividness	The theory of vividness (Steuer, 1992) posits that the mental process of visualization can be supported via rich and vivid presentation of information	The reviewed literature investigated, for example, how vivid product presentations via AR affect different consumer responses (e.g. perceived usefulness, enjoyment, immersion, etc.)	McLean and Wilson (2019), Mishra *et al.* (2021), Yim *et al.* (2017)	3	7.9
Cognitive theory of multimedia learning	The cognitive theory of multimedia learning (Mayer and Moreno, 2003) has its roots in educational psychology and suggests that there are different channels by which individuals process information (i.e. audio and visual)	From this dual-channel theorization, the reviewed studies especially explored how the visual cues of presenting a product via AR technology affects the visual cognitive channel for processing information compared to non-AR product presentations	Fan *et al.* (2020), Tarafdar *et al.* (2019)	2	5.3
Mental imagery theory	Mental imagery is understood as the mental process involved when humans visualize something (Lutz and Lutz, 1978)	The screened literature draws on this notion to explore how AR can support consumers in their mental image processing of products	Heller *et al.* (2019a), Park and Yoo (2020)	2	5.3
Self-referencing theory	Self-referencing theory (Kuiper and Rogers, 1979) postulates that individuals process information better if they are themselves by some means referenced in the information	This concept has been used to explore how self-presentation via AR (e.g. via virtual mirrors) affects individuals brand attitudes and purchase intentions	Huang (2019), Smink *et al.* (2019)	2	5.3

(*continued*)

Table 7.
Overview of cognitive theories

Background, concepts, theories	Explanation	Adaptation in the AR shopping literature	Studies	#	%
Active inference theory	Active inference theory (Friston, 2018) suggests that perceptions are subject to an active process in which the beliefs of individuals can be updated, e.g. through context learning	This notion was used to explain how the multisensory proficiency of AR technology is capable of guiding customer perceptions of products (e.g. via interacting and trying out the virtual products and receiving sensory feedback)	Heller *et al.* (2019b)	1	2.6
Cognitive fit theory	According to cognitive fit theory (Vessey, 1991), individuals' task performance can be enhanced when they perceive that the features provided by a technology correspond well with their intended tasks and goals	Based on the notion of cognitive fit theory, it was examined how AR technology can affect the cognition of users and essentially support purchase intentions	Haile and Kang (2020)	1	2.6
Cognitive load theory/cognitive fluency theory	According to cognitive load theory (Sweller and Chandler, 1991), humans have a limited cognitive capacity and with increasing cognitive exertion, it becomes more demanding for individuals to acquire and process information. Cognitive fluency theory (Alter and Oppenheimer, 2009) also presupposes a limited cognitive capacity of humans and suggests that there are different degrees of difficulty in processing information, for example, based on how familiar an individual is with the exposed stimuli	Within the reviewed literature, these theories have been applied to investigate whether and how AR can increase or decrease cognitive load during shopping and how it affects attitudes of customers (e.g. towards the technology or products) as well as purchase decisions	Fan *et al.* (2020)	1	2.6
Cue-utilization theory	According to cue-utilization theory (Easterbrook, 1959), individuals experience higher levels of arousal when they experience new or unfamiliar stimuli, which can lead to higher levels of attention	Based on the suggestions from cue-utilization theory and the premise that AR provides novel stimuli to inexperienced users, it was explored how previous experience with AR is related to perceptions of AR (e.g. media novelty, immersion)	Yim *et al.* (2017)	1	2.6

Table 7.

(*continued*)

Background, concepts, theories	Explanation	Adaptation in the AR shopping literature	Studies	#	%
Elaboration likelihood model (ELM)	The elaboration likelihood model is a relevant theory in research on media effects. It is based on the notion that messages received through media can be processed through two different routes (i.e. central and peripheral) depending on the level of motivation that the recipient has to process the messages, and attitudes are formed differently depending on the route taken	ELM was used to explore how AR influences users with different levels of involvement. This was done based on the notion that if a recipient has sufficient motivation (high involvement) and receives a relevant message, it is processed through the central cognitive route whereas the peripheral route is taken if a recipient has low motivation (low involvement)	Park and Yoo (2020)	1	2.6
Flow theory	Flow is defined as a mental state of deep concentration or immersion that can transpire when an individual is fully engaged in an activity (Nakamura and Csikszentmihalyi, 2014)	It was explored how perceived augmentation can contribute to immersing individuals into a state of flow, thereby giving rise to desirable affective and cognitive responses as well as behavioral intentions	Javornik (2016)	1	2.6
Stimulus-organism-response (S-O-R) model	The S-O-R model is a broad and generic concept to explain human decision processes. Most simply put, it suggests that different forms of stimuli (S) affect consumers' internal cognitive evaluation (a process within the organism) (O) that leads to a response (R)	Within the reviewed literature, AR is seen as a technology that provides stimuli, affecting cognitive evaluation and essentially giving rise to customer responses, for example, in terms of attitude formation and behavioral intentions	Qin *et al.* (2021b)	1	2.6

Table 7.

systems (Venkatesh *et al.*, 2012). For example, it also considers hedonic experientiality (e.g. enjoyment), which has been regarded as a relevant predictor for AR brand engagement (McLean and Wilson, 2019) and the intention to use AR technology (Saprikis *et al.*, 2021). Therefore, besides drawing on theories that focus on pragmatic values, such as informativeness (e.g. information richness theory) (Qin *et al.*, 2021b) or whether the technology serves its intended purpose (e.g. task-media-fit theory) (Choi and Choi, 2020), several of the reviewed studies also drew on dedicated theories that focus on user experientiality, such as the typology of experiential value (Dacko, 2017) or experience economy theory (Choi and Choi, 2020).

In addition, there seems to be a great interest in terms of the cognitive perspective when investigating AR (see Table 7). The employed theories consider the cognitive processing, cognitive load (e.g. Fan *et al.*, 2020), mental imagery, and mental support (e.g. Heller *et al.*, 2019a; Park and Yoo, 2020) that AR can elicit as well as learning-related cognitive facets (Fan *et al.*, 2020; Tarafdar *et al.*, 2019). Altogether, 39.5% of the reviewed studies utilized cognitive theories, drawing a picture that reveals that the current empirical literature on AR shopping is captivated by the cognitive benefits and challenges stemming from the use of AR technology.

Generally speaking, it is noteworthy that the majority of theories have only been tested three or fewer times. Thus, besides broadening our view by exploring a plethora of different theories, it seems necessary to further validate the sparingly encountered theories in order to receive an even more concise picture of the relevant adoption factors for AR and the circumstances that may either support or impede consumers cognitively when using the technology.

4.5 What AR technology characteristics are investigated?

Usually analyzed as independent variables, the reviewed literature investigated several AR technology characteristics (see Table 8) and how they affect individuals' psychological and behavioral outcomes.

Previous characterizations of AR involved three central attributes, namely interactivity, vividness as well as novelty (Azuma, 1997) and these aspects are also reflected in the reviewed literature. Most considerably, the analyzed studies investigated AR in terms of interactivity (in 28.9% of studies) (e.g. simulated physical control, rehearsability, sensory control, etc.). Interactivity is regarded as the degree to which users can perform real-time modifications with virtual objects in the mediated environment (Steuer, 1992). In the reviewed literature, it was investigated how interactive proficiencies of AR technology influences consumers value perceptions (Hilken *et al.*, 2017), attitudes (Fan *et al.*, 2020; Qin *et al.*, 2021b), brand engagement (McLean and Wilson, 2019) as well as affective outcomes (Kowalczuk *et al.*, 2021) and cognitive processes (Fan *et al.*, 2020; Haile and Kang, 2020; Heller *et al.*, 2019a, b).

AR characteristics	Studies	#	%
AR attributes			
Interactivity, simulated physical control, rehearsability, sensory feedback and control/self-empowerment, transformation	Fan *et al.* (2020), Haile and Kang (2020), Heller *et al.* (2019a), Heller *et al.* (2019b), Hilken *et al.* (2017), Huang (2019), Kowalczuk *et al.* (2021), McLean and Wilson (2019), Pantano *et al.* (2017), Poushneh (2018), Qin *et al.* (2021b)	11	28.9
Vividness, environmental embedding, AR imagery generation/configuration	Fan *et al.* (2020), Heller *et al.* (2019a), Hilken *et al.* (2017), McLean and Wilson (2019), Qin *et al.* (2021b), Yim *et al.* (2017)	6	15.8
Novelty/Innovativeness	McLean and Wilson (2019), Saprikis *et al.* (2021), van Esch *et al.* (2019), Yim *et al.* (2017)	4	10.5
Informativeness			
Information provided, information quality/product informativeness	Kowalczuk *et al.* (2021), Lu and Smith (2010), Pantano *et al.* (2017), Poushneh (2018), Yoo (2020)	5	13.2
Product contextuality/complexity	Heller *et al.* (2019a), Tarafdar *et al.* (2019)	2	5.3
Recommendations, communicate acts, point-of-view sharing	Adam and Pecorelli (2018), Hilken *et al.* (2020)	2	5.3
Quality/performance			
Mapping/visual quality	Poushneh (2018), Yoo (2020)	2	5.3
Response time/responsiveness	Pantano *et al.* (2017), Park and Yoo (2020)	2	5.3
System quality/service excellence	Huang and Liao (2015), Kowalczuk *et al.* (2021)	2	5.3
Reality congruence	Kowalczuk *et al.* (2021)	1	2.6

Table 8. Overview of the explored AR technology characteristics

The second most encountered AR attribute (encountered in 15.8% of studies) has to do with the visual representation of the AR objects and the mediated environment (i.e. vividness, AR imagery, environmental embedding, etc.). Vividness is understood as the representational richness of a medium and it has formerly been argued to be a vital aspect (alongside interactivity) for giving rise to immersive experiences (Steuer, 1992). Several of the analyzed studies yield important empirical support for this proposition (e.g. Hilken *et al.*, 2017; Yim *et al.*, 2017). The reviewed literature further tried to capture if and how contrasting degrees of vividness and interactivity affect users differently, for example, via comparing AR to conventional 2D static product representations or by comparing different AR configurations (i.e. high vs low imagery configurations). According to the examined literature, advantages of higher degrees of interactive and vivid product presentations include lower effort for mental imagery processes (Heller *et al.*, 2019a) as well as increased perceptions of enjoyment, usefulness, and ease of use (McLean and Wilson, 2019; Yim *et al.*, 2017).

As mentioned, novelty (encountered in 10.5% of studies), which can be defined as the perceived uniqueness or newness of stimuli (Massetti, 1996), is considered as a third main attribute of AR technology (Yim *et al.*, 2017). Even though several of the reviewed studies found positive effects that can be attributed to the perceived novelty of AR (McLean and Wilson, 2019; Yim *et al.*, 2017), it is arguably becoming a more disputable matter to still consider AR as novel. In the past decade, the technology became more and more mainstream and therefore, it is not surprising that, in comparison to interactivity and vividness, it has been less of a focal point in the screened literature, which covers the past 10 years of empirical shopping-related AR studies. On the account of AR becoming more and more ubiquitous, novelty effects were investigated in combination with past experience of users and results indicate that indeed, novelty effects wear off with increased experience with the medium (Yim *et al.*, 2017).

Whereas novelty and perhaps even the hedonic perceptions of AR may decrease with more widespread experience with the technology, it becomes increasingly important to understand how AR can provide utilitarian benefits to consumers. One major aspect of AR in shopping that seems to become more relevant, not least due to the increasing shift towards online shopping, is to examine how AR can support the informativeness of users. The reviewed literature not only investigated how AR can enhance informativeness via its interactive and rich product presentations, it was also explored how rather unique affordances such as point-of-view sharing between consumers (Hilken *et al.*, 2020) or displaying consumer recommendations in the AR environment (Adam and Pecorelli, 2018) influence purchase intentions. Some of the encountered results indicate that higher levels of informativeness and high-quality information in AR can reduce uncertainties about products (Adam and Pecorelli, 2018), increase usefulness perceptions and positively influence choice confidence (Kowalczuk *et al.*, 2021). Against the background of these utilitarian benefits, it seems important that future research investigates current developments in terms of affording AR systems with new ways of presenting information. At the same time and in direct relation to this, it becomes relevant to explore how additional information during virtual product presentation affects users cognitively. For example, it remains unclear where the fine line lies between a good amount of information that enhances consumers' informativeness and too much information that may cause cognitive overload.

Noticeably, aspects related to the quality and performance of the AR applications, such as response time (Pantano *et al.*, 2017; Park and Yoo, 2020), visual quality (Poushneh, 2018; Yoo, 2020), or overall system quality (Kowalczuk *et al.*, 2021), have been only occasionally examined (see aspects subsumed in Table 8 under *Quality/performance*). While these aspects are undeniably important for providing a pleasant user experience, they may have faded somewhat into the background in recent years, due to the circumstance that AR technology matured immensely over the past decade, and thus, the technological prowess of AR became less of a matter for investigation. Rather, it seems that the interaction between humans and AR technology, or for that matter the effects that the technology has on humans in terms of psychological and behavioral outcomes, is becoming imperative in current AR research (see next subsection).

4.6 What is known about the effects of AR on consumers during shopping?

All of the analyzed studies indicate generally positive effects of AR in shopping contexts (the minority of the studies also report mixed results, e.g. non-significant relationships). While only a few of the studies raise potential concerns and report on detrimental outcomes, none of the studies exclusively report on negative results. In the following, we present the encountered cognitive (4.6.1), affective (4.6.2), social (4.6.3), and behavioral intention (4.6.4) outcomes in the reviewed body of literature.

4.6.1 Cognitive outcomes. In terms of the cognitive outcomes (see Table 9), we encountered that perceived usefulness (39.5%) and usability (28.9%) have been the most explored outcome variables in the reviewed literature. These two aspects represent important determinants for the formation of attitudes according to some of the most prominent theories of IT adoption (e.g. TAM, UTAUT). Consequently, scholars have looked towards these

Cognitive/overall usage perceptions	Studies	#	%
Perceived usefulness/performance expectancy/pragmatic/utilitarian	Bonnin (2020), Dacko (2017), Hilken *et al.* (2017), Huang and Liao (2015), Kowalczuk *et al.* (2021), McLean and Wilson (2019), Pantano *et al.* (2017), Poushneh and Vasquez-Parraga (2017), Qin *et al.* (2021b), Rese *et al.* (2017), Saprikis *et al.* (2021), Spreer and Kallweit (2014), Yim *et al.* (2017), Yoo (2020), Zhang *et al.* (2019)	15	39.5
Usability/perceived ease of use/effort expectancy	Huang and Liao (2015), Lu and Smith (2010), McLean and Wilson (2019), Mishra *et al.* (2021), Morillo *et al.* (2019), Pantano *et al.* (2017), Qin *et al.* (2021b), Rese *et al.* (2017), Saprikis *et al.* (2021), Spreer and Kallweit (2014), Zhang *et al.* (2019)	11	28.9
Cognitive load, cognitive processing fluency, cognitive innovativeness, mental elaboration, mental intangibility	Fan *et al.* (2020), Haile and Kang (2020), Heller *et al.* (2019a, b), Huang and Liao (2015), Park and Yoo (2020), Tarafdar *et al.* (2019)	7	18.4
Perceived informativeness/knowledge	Choi and Choi (2020), Haile and Kang (2020), Qin *et al.* (2021b), Rese *et al.* (2017), Smink *et al.* (2019)	5	13.2
Perceived aesthetics/store attractiveness	Bonnin (2020), Huang and Liao (2015), Pantano *et al.* (2017), Poushneh and Vasquez-Parraga (2017)	4	10.5
Perceived privacy risk/intrusiveness/trust	Saprikis *et al.* (2021), Smink *et al.* (2019, 2020), Zhang *et al.* (2019)	4	10.5
Product fit uncertainty/product risk perceptions	Adam and Pecorelli (2018), Bonnin (2020), Tarafdar *et al.* (2019), Zhang *et al.* (2019)	4	10.5
Confidence level	Lu and Smith (2010), van Esch *et al.* (2019)	2	5.3
Perceived augmentation	Javornik (2016), Javornik *et al.* (2016)	2	5.3
Perceived controllability/(User's control)	Javornik (2016), Park and Yoo (2020)	2	5.3
Perceived ownership/sense of ownership control	Brengman *et al.* (2019), Huang (2019)	2	5.3
Creativity	Jessen *et al.* (2020)	1	2.6
Curiosity	Beck and Crié (2018)	1	2.6
Perceived personalization	Smink *et al.* (2020)	1	2.6
Self-referencing/IT-Identity	Huang (2019)	1	2.6

Table 9. Overview of the cognitive outcomes

theories to explain the adoption of AR technology and largely substantiate the aptitude of these IT adoption theories in the realm of AR shopping (e.g. Huang and Liao, 2015; McLean and Wilson, 2019; Pantano *et al.*, 2017; Qin *et al.*, 2021b; Rese *et al.*, 2017; Saprikis *et al.*, 2021; Spreer and Kallweit, 2014).

However, these traditional adoption theories have their limitations in terms of explaining the cognitive conditions of individuals when using contemporary technology, such as AR. In AR, users have to cognitively process a mixed reality (i.e. the virtual and the physical) (Xi *et al.*, 2022). Therefore, analyzing the cognitive condition of users during AR shopping seems particularly relevant. This is also reflected in the analyzed literature. As presented in section 4.4, the current AR shopping literature is devoutly drawing on cognitive theories to explain how AR affects users cognitive load (Fan *et al.*, 2020), mental imagery, mental support (Heller *et al.*, 2019a; Park and Yoo, 2020), learning-related cognitive facets (Fan *et al.*, 2020; Tarafdar *et al.*, 2019), and so on. Interestingly, we encountered some ambivalent indications in the screened articles concerning the cognitive demand of AR as well as its perceived ease of use. In one study, users perceived a conventional (non-AR) solution as easier to use as compared to an AR solution (Lu and Smith, 2010), and another encountered that individuals' cognitive load was higher when using an AR interface in comparison to conventional product presentation (Tarafdar *et al.*, 2019). However, there is also ample support from the reviewed literature that AR can cognitively support users. For example, it has been demonstrated that AR can support users' cognitive fluency (Fan *et al.*, 2020) and reduce the mental intangibility of products, which can support decision making (Heller *et al.*, 2019a, b) and product attitudes (Fan *et al.*, 2020). These results indicate that there is still much to learn in terms of how and under what conditions AR can support or impede cognitive processes.

Another aspect that seems to gain ground is the informativeness that individuals experience when using AR for shopping. Several studies empirically demonstrate that AR can enhance consumers' perceived informativeness during shopping, which can influence brand attitude (Smink *et al.*, 2019), perceived usefulness (Rese *et al.*, 2017), affection, and purchase intentions (Haile and Kang, 2020). According to Qin *et al.* (2021b), the virtuality and interactivity features of AR contribute to consumers' informativeness. Several studies also found that AR technology can reduce product risk perceptions (Bonnin, 2020; Tarafdar *et al.*, 2019) and that it is superior in informing consumers about products as compared to non-AR solutions that rely on, for example, conventional 2D or non-interactive 3D product presentations (Choi and Choi, 2020; Smink *et al.*, 2019). It has also been argued that additional information in the form of recommendations in AR environments can reduce product fit uncertainties (Adam and Pecorelli, 2018). However, there may be a fine line between the right amount of information to support users in terms of both, cognitive exertion and informativeness, and too much information that may cognitively overload consumers and negatively influence attitudes, which is something that should be scrutinized in future research.

A fine line may also exist between perceived personalization (Smink *et al.*, 2020) or sense of ownership (Brengman *et al.*, 2019; Huang, 2019) and perceived privacy risk (Zhang *et al.*, 2019) or intrusiveness (Smink *et al.*, 2019, 2020). This may be especially true for AR solutions that represent virtual mirrors. On the one hand, consumers may fancy seeing themselves and being able to virtually try on a product, while at the same time, consumers may perceive the AR app as intrusive (Smink *et al.*, 2019), for example, for having to give access to their camera and by not knowing how their personal data will be used.

Further cognitive outcomes that have been encountered in the reviewed literature as a result of using AR technology are perceived augmentation (Javornik, 2016; Javornik *et al.*, 2016), perceived aesthetics or store attractiveness (Bonnin, 2020; Huang and Liao, 2015), increased curiosity about products (Beck and Crié, 2018), a higher sense of expressing oneself, thereby influencing IT-identity (Huang, 2019) as well as a higher sense of control because users can interact with products (Javornik, 2016; Park and Yoo, 2020). These results show that AR can give rise to diverse cognitive responses that can influence the adoption of AR for shopping, which may, however, also be subject to various personality-related aspects, such as prior experience with AR, individuals' cognitive abilities, personal tendencies to have higher privacy risk perceptions and other individual-based tendencies and characteristics.

4.6.2 Affective outcomes. Concerning the encountered affective outcomes (see Table 10), the reviewed literature mostly investigated how AR influences consumers' hedonic perceptions (e.g. enjoyment, playfulness, fun, entertainment). Such outcomes are naturally associated with intrinsic motivation, which means that users engage in actions not because it is enforced but because they inherently enjoy it and want to (Deci and Ryan, 2010). According to the reviewed literature, these hedonic perceptions largely affect positive attitudes (Pantano *et al.*, 2017; Qin *et al.*, 2021b), store attractiveness (Bonnin, 2020), brand engagement (McLean and Wilson, 2019), and user satisfaction (Poushneh and Vasquez-Parraga, 2017). Moreover, AR is argued to be capable of giving rise to flow and spatial presence, thus immersing consumers in the shopping experience (Hilken *et al.*, 2017; Javornik, 2016; Kowalczuk *et al.*, 2021; Yim *et al.*, 2017). Further affective responses of using AR involve having higher choice confidence or decision comfort (Heller *et al.*, 2019a; Hilken *et al.*, 2017; Kowalczuk *et al.*, 2021). Despite these diverse positive outcomes of using AR, the reviewed literature also reports on negative user judgments of the technology (Dacko, 2017) and encountered potential adverse effects of AR, such as irritation (Haile and Kang, 2020) and discomfort, which can essentially negatively impact attitudes (van Esch *et al.*, 2019). Nevertheless, except for these few studies that view potential negative effects, the reviewed literature reports almost exclusively on positive outcomes. We deem it important that future studies also report or specifically focus on potential problematic effects of using AR in shopping, as this can provide important

Table 10.
Overview of affective outcomes

Affective outcomes	Studies	#	%
Enjoyment/playfulness/hedonic/intrinsic value	Bonnin (2020), Choi and Choi (2020), Dacko (2017), Haile and Kang (2020), Hilken *et al.* (2017), Huang and Liao (2015), Javornik (2016), Kowalczuk *et al.* (2021), McLean and Wilson (2019), Pantano *et al.* (2017), Park and Yoo (2020), Poushneh and Vasquez-Parraga (2017), Qin *et al.* (2021b), Rese *et al.* (2017), Saprikis *et al.* (2021), Smink *et al.* (2019), Spreer and Kallweit (2014), Yim *et al.* (2017), Zhang *et al.* (2019)	19	50.0
Attitude/affection/overall evaluation	Brengman *et al.* (2019), Choi and Choi (2020), Fan *et al.* (2020), Haile and Kang (2020), Javornik (2016), Kowalczuk *et al.* (2021), Lu and Smith (2010), Mishra *et al.* (2021), Moriuchi *et al.* (2020), Pantano *et al.* (2017), Qin *et al.* (2021b), Rese *et al.* (2017), Smink *et al.* (2019), van Esch *et al.* (2019), Yim *et al.* (2017), Zhang *et al.* (2019)	16	42.1
Immersion/presence/flow	Hilken *et al.* (2017), Huang and Liao (2015), Javornik (2016), Kowalczuk *et al.* (2021), Smink *et al.* (2020), Tarafdar *et al.* (2019), Yim *et al.* (2017)	7	18.4
Satisfaction	Jessen *et al.* (2020), McLean and Wilson (2019), Moriuchi *et al.* (2020), Poushneh (2018), Poushneh and Vasquez-Parraga (2017), Tarafdar *et al.* (2019), Yoo (2020)	7	18.4
Decision comfort/choice confidence	Heller *et al.* (2019a, b), Hilken *et al.* (2017), Kowalczuk *et al.* (2021)	4	10.5
Adverse effects (e.g. discomfort, irritation, negative judgement etc.)	Dacko (2017), Haile and Kang (2020), van Esch *et al.* (2019)	3	7.9
Desire for product	Hilken *et al.* (2017)	1	2.6
Brand love	Huang (2019)	1	2.6

insights into what pitfalls should be avoided when using AR and how the technology should be employed to effectively support consumers during shopping.

4.6.3 Social outcomes. In addition to the encountered cognitive and affective outcomes, there have been several social aspects that have been analyzed in the reviewed literature (see Table 11). These involve social aspects, such as subjective norm (i.e. the perception of an individual that significant others, such as friends or family, believe that he or she should use a system) (McLean and Wilson, 2019; Saprikis *et al.*, 2021), as well as perceived socialization (Zhang *et al.*, 2019) and social empowerment (Hilken *et al.*, 2020). Normally, users are individually engaged in shopping, however, as these few studies argue, there may be also some social components that could play a role during AR shopping, such as perspective-taking (or point-of-view sharing) (Hilken *et al.*, 2020) as well as sharing and social media features (Zhang *et al.*, 2019). However, so far, the social capabilities of AR have been investigated only sparingly but could bring in a unique and potentially worthwhile view for future AR research.

4.6.4 Behavioral intention outcomes. In terms of the behavioral intention outcomes (see Table 12), which are naturally succeeded by the psychological aspects discussed above, the analyzed literature was mostly concerned with investigating how AR affects purchase intentions or willingness to buy (in 50.0% of the studies). This is not surprising, as practitioners are largely interested in utilizing AR technology to gain economic value. The second most analyzed behavioral result was the intention to use or reuse an AR app (in 36.8% of studies). The studies chiefly confirm that sellers can anticipate from employing AR technology that consumers will perceive greater benefits and will be encouraged to return to the store or the AR app. In addition, according to the screened literature, retailers may expect

Social outcomes	Studies	#	%
Subjective norms	McLean and Wilson (2019), Saprikis *et al.* (2021)	2	5.3
Perceived socialization	Zhang *et al.* (2019)	1	2.6
Social empowerment	Hilken *et al.* (2020)	1	2.6

Table 11. Overview of the social outcomes

Behavioral outcomes	Studies	#	%
Purchase intention/willingness to buy	Adam and Pecorelli (2018), Beck and Crié (2018), Brengman *et al.* (2019), Choi and Choi (2020), Haile and Kang (2020), Heller *et al.* (2019a, b), Hilken *et al.* (2017, 2020), Javornik (2016), Javornik *et al.* (2016), Kowalczuk *et al.* (2021), Moriuchi *et al.* (2020), Pantano *et al.* (2017), Park and Yoo (2020), Poushneh and Vasquez-Parraga (2017), Smink *et al.* (2019), Yim *et al.* (2017), Zhang *et al.* (2019)	19	50.0
Intention to use/reuse AR app/revisit AR store/loyalty towards app	Beck and Crié (2018), Bonnin (2020), Huang and Liao (2015), Javornik (2016), Javornik *et al.* (2016), Jessen *et al.* (2020), Kowalczuk *et al.* (2021), Moriuchi *et al.* (2020), Park and Yoo (2020), Qin *et al.* (2021b), Rese *et al.* (2017), Saprikis *et al.* (2021), Spreer and Kallweit (2014), Yoo (2020)	14	36.8
Intention to recommend/WOM intention	Heller *et al.* (2019a), Hilken *et al.* (2017, 2020), Javornik (2016), Javornik *et al.* (2016), Mishra *et al.* (2021), Park and Yoo (2020)	7	18.4
Brand engagement/brand responses	McLean and Wilson (2019), Smink *et al.* (2020)	2	5.3
Willingness to share personal data	Smink *et al.* (2019)	1	2.6

Table 12. Overview of the behavioral intention outcomes

from using AR technology that consumers perceive greater brand engagement (McLean and Wilson, 2019; Smink *et al.*, 2020), and that they are more likely to recommend the store to others (Heller *et al.*, 2019a; Hilken *et al.*, 2020; Javornik *et al.*, 2016) and even that they may value the benefits of AR so much that they are more willing to share personal information (Smink *et al.*, 2019).

5. Discussion

The present systematic literature review contributes to current AR research by providing an overview and synthesis of the empirical literature ($n = 38$) devoted to AR shopping from the past ten years and by conceptualizing a framework for AR induced consumer behavior in shopping (Figure 5). Besides reporting on where AR is employed (e.g. online vs in-store), what devices are used, and what types of products are typically investigated, this review provides an important contribution to current research by synthesizing and structuring the theories that have so far been employed in the empirical literature on AR shopping, and by providing an overview of the technological characteristics that are commonly studied as well as what psychological (cognitive, affective and social) and behavioral outcomes AR has been found to evoke.

5.1 Theoretical implications

In accordance with the conceptualization of AR shopping illustrated in the background section (see Figure 1), we specifically focused on the technological characteristics of AR as well as the psychological and behavioral outcomes that AR is capable of evoking. Figure 5 reinstates this conceptualization in accordance with the findings of the present study, thereby cementing a framework for AR induced consumer behavior in shopping. Specifically, the

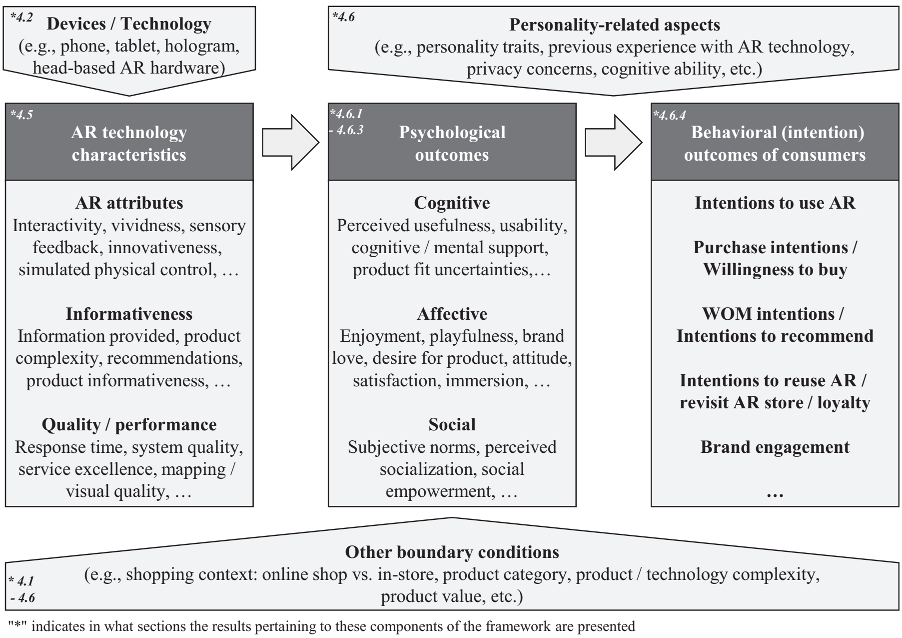


Figure 5.
Framework for AR induced consumer behavior in shopping

framework is mapped in accordance with the presented results in Sections 4.1–4.6 ("*" indicates in what sections the results about the different components of the framework are presented). Overall, this framework indicates that the diverse technological characteristics of AR (subsumed as AR attributes, as well as aspects related to informativeness and quality/performance) can invoke various cognitive, affective, and social psychological outcomes, which in turn can translate into behavioral outcomes, such as purchase intentions, loyalty, use and reuse intentions, as well as WOM intentions. Figure 5 also reveals that there may be several personality-related aspects or other boundary conditions that can affect these dynamics. Pertaining to the technological characteristics, the most commonly investigated ones have to do with the interactivity, vividness, and informativeness of AR, which are important attributes to provide hedonic and utilitarian benefits for consumers. Both the utilitarian and hedonic virtue have been indicated to be significant driving forces behind AR adoption. In terms of the cognitive psychological outcomes, we encountered that utilitarian perceptions, such as usefulness, were most pivotal, whereas from the affective psychological perspective, hedonic perceptions, such as perceived enjoyment and playfulness, were most frequently investigated. For example, as indicated by the extant literature, AR is capable of giving rise to enjoyable, entertaining, playful, and immersive experiences, which can influence brand engagement (McLean and Wilson, 2019; Smink *et al.*, 2019), store attractiveness (Bonnin, 2020) and intentions to recommend AR online stores to others (Hilken *et al.*, 2017). On the other hand, the utilitarian virtue of AR stems from the technological abilities such as the vivid depictions of products and interactive functionalities, which allow users to engage with virtual products more meaningfully, thereby enhancing, for example, consumers' informativeness (Qin *et al.*, 2021b), mental imagery, and decision comfort (Heller *et al.*, 2019a). From the in-depth theoretical analysis provided in Section 4.4, we encountered that besides traditional consumer and technology acceptance concepts, there is a great interest in cognitive theories to explain the effects and adoption of AR for shopping. Despite some ambiguous results, the reviewed literature chiefly supports the notion that AR can help users to cognitively process product information. However, with the increasing complexity of AR technology and increasing amounts of augmented information, there seems to be a need in the future to theoretically inquire and empirically investigate under what circumstances AR affects user cognition positively or negatively. For example, AR may be perceived differently depending on user traits, previous experience with AR, product types, shopping context, degree of information, and other aspects, making it necessary to consider different boundary conditions when theorizing the effects of AR on consumer behavior.

5.2 Practical implications

The reviewed literature largely offers a coherent picture that AR technology can effectively support shopping processes, both in-store and online. It can serve as an interactive marketing medium that can draw in the attention of consumers and invoke intentions to revisit an online store as well as help consumers make decisions to buy products. Overall, the observations from the analyzed studies confirm that AR is more effective in providing consumers with the necessary degree of information to purchase products online compared to traditional online shops that offer non-interactive 2D product presentations. The COVID-19 pandemic has provoked a heightened demand for consumers to shop online, perhaps giving shop providers that offer extended reality functionality a competitive edge over providers that do not offer such functionality (Díaz-Martín *et al.*, 2021). Reports from the industry draw a similar picture, indicating that the COVID-19 pandemic has had a tremendous impact on digital shopping and that AR has been the technological trend that retail companies turned to, resulting in advantages such as increased sales conversion rates (Papagiannis, 2020). Therefore, it stands to reason that it should be one of the priorities of online shop providers to integrate AR within their marketing and retailing strategies.

With regards to the analyzed products, the current literature focuses mainly on low-complexity products such as fashion, furniture, and makeup, whereas products of higher complexity, such as technology products are hardly ever investigated. As a result, it remains nebulous whether AR is equally capable of supporting purchase decisions for these types of products. Therefore, the findings pertaining to the effectiveness of AR technology should be regarded with more caution for retailers that sell products of higher complexity and high economic value. Moreover, it is striking that the investigated AR solutions offer limited variety in terms of the range of functionality. They are almost exclusively limited to the ability to display and interact with virtual products in the physical space. Options to change particular features such as color, or the provision of other sensory information, such as sound, remain modest. In particular, we found that current AR solutions do not possess the ability to superimpose additional information alongside the product, such as performance ratings, star ratings, customer reviews, or similar informative cues about products. Practitioners are advised to look into these and similar design interventions that could enhance the user experience of AR technology even further. This is important because there is a limited understanding of whether such features and cues can result in lower product risk perceptions, better informativeness, enhanced decision comfort, and other pragmatic outcomes, or if there are also potential detrimental effects such as heightened cognitive exertion that needs to be taken into consideration. Investigations into this direction may reveal important design implications for practitioners, such as the provision of layered information by which product details can be dynamically embedded by the user (e.g. via hand motions or a finger tap on a specific part of a virtually presented product). Such design interventions may not only result in heightened utilitarian perceptions but also in a more personalized experience that gives way to more autonomy when users engage with AR technology, which in consequence can result in a more intrinsically fulfilling and meaningful user experience.

5.3 Future research avenues

5.3.1 Thematic agenda. The reviewed studies revealed a very consistent picture in terms of the analyzed products. Mostly, furniture, fashion, and makeup products have been investigated. Often, such products are referred to as experience products because consumers can directly experience these, for example, in the case of furniture products within their intended environment or in the case of fashion or makeup products via virtual mirrors on themselves. On the other hand, search products or products of high complexity (e.g. technology products), have been less represented in the reviewed studies. This points to the thematic gap that we still have little knowledge in terms of how well AR solutions support informativeness and purchase decisions of high complexity and potentially high-value products. Future research should address this gap because it may reveal whether AR technology, specifically in online shops, can be equally proficient and desirable for evaluating products with distinct features, complexity, value, and other traits (see boundary conditions in Figure 5), or whether consumers prefer going to physical stores to evaluate certain types of products (e.g. to minimize risks). Hence, such inquiries can result in relevant implications for practitioners in regard to what product categories they should provide AR solutions for and what types of products current AR solutions may be less qualified for. In the same vein, investigations into this direction may advance the technological evolution of AR as it may expose important design implications for AR systems based on product types, for example, in terms of what further visual or other sensory details need to be presented to give users a more complete picture and essentially more confidence when evaluating expensive and complex products. As AR technology continues to evolve at a fast pace, it is foreseeable that AR solutions can increasingly cope with the technological requirements to virtually present even high complexity products to a satisfactory degree. Thus, it seems an important future venture to explore more frequently how well AR can lower product risk perceptions and support consumers' informativeness and decision-making during shopping of high complexity and high-value products.

Agenda point 1: Explore a more diversified assortment of products (including high-complexity and high-value products).

Future studies should expand the scope of applying AR in the shopping domain, for example, in terms of investigating AR in different shopping environments (e.g. location-based situational shopping, online, mobile, physical, and a combination of AR with VR). The majority of previous studies have investigated the applications of AR in online web-based shopping (subsumed under "Other boundary conditions" in Figure 5), which reshapes consumers' shopping experience with the overlaid product information such as try-on experience, interactivity, and vividness (see "AR technology characteristics" in Figure 5). In fact, AR as a technology for providing augmented information can be applied to any shopping environment and consumers' experience and perception towards using AR might differ. For example, in physical shopping, the main reason for most consumers using AR may be to obtain extra information; while in augmented virtuality (i.e. augmented information in VR) environments, consumers may expect to have more innovative and personalized experiences via interacting with AR content. Importantly, there has been no study from our reviewed set of literature that explores the potentials of augmented virtuality and thus, it seems an important future waypoint to investigate how such solutions may be perceived by consumers. In addition, there may be further situations in which especially mobile devices can unleash their full potential, e.g. via location-based service. For example, a consumer may be notified of a coupon via a pop-up message when nearby a store, and the coupon could be superimposed onto the real environment via AR and collected by the user. This adds a playful and engaging component to AR and may draw the user to the nearby store to redeem the coupon. This is just one of many potential examples for which AR can be combined with other contemporary technologies and services that seem exciting and necessary to be explored more often in future research.

Agenda point 2: Explore the application of AR in various shopping contexts and in combination with other contemporary technologies.

Shopping online is often considered as an individual endeavor, yet, it should be noticed that social experience (e.g. social interaction, norms, support, and communication) can play an important role in consumers' purchase intention and decision making (Handarkho, 2020). For example, shoppers usually interact with peers or shopping assistants for getting social support (Yahia *et al.*, 2018), and they display information sharing behaviors such as giving recommendations and Word-of-Mouth (Ryu and Park, 2020) or seek for symbolic interaction and benefit (Rintamäki *et al.*, 2006). People have intrinsic needs for socialization and relatedness (Deci and Ryan, 2010), and AR may provide novel possibilities for synchronous and asynchronous interaction between users with virtual content. For example, users may share perspectives with others, share notes, comments, or recommendations, perhaps even simultaneously modify virtual products to share ideas, and so on. These affordances can be relevant to enhance the social experience during AR shopping and evoke important social-psychological outcomes that can reinforce technology adoption (the social experience is subsumed under "Psychological outcomes" in Figure 5). However, as revealed in the present study (see Table 11), inquiries into the social capabilities of AR during shopping remain meager in the current literature and thus, we have little understanding of how to employ such potentially rewarding capabilities in AR shopping processes. Therefore, we encourage researchers to explore the social value of AR (e.g. by providing social information, reviews, comments, interaction possibilities with peers or shopping assistants, and opportunities for group shopping) and investigate whether and how it further influences the shopping experience.

Agenda point 3: Explore the social experience in AR shopping.

We encountered that almost all studies were focused on the positive effects of using AR during shopping, whereas only a few studies also report on potential negative judgments or negative effects. Arguably, it is more likely that studies focus on reporting positive oriented results, however, we deem it also important that inquiries into potential adverse effects are conducted, because this can result in crucial insights into potential pitfalls and how they can be avoided when designing or employing AR for shopping. For example, AR may not be equally desirable for all user groups, or equally effective for all types of products or settings. So far, research around AR shopping has focused only on limited types of products and user groups. In addition, there may be design characteristics or other circumstances in which AR could be perceived as irritating, frustrating, discouraging, and so on, which may affect users negatively, both mentally and physically. These issues seem underexplored in the current literature and hence, we deem it important that more inquiries are conducted into circumstances and conditions in which potential adverse effects may emerge from using AR during shopping.

Agenda point 4: Explore potential adverse effects of using AR technology during shopping.

Future studies should enhance the exploration of moderators to gain an in-depth understanding of the boundary conditions of applying AR in shopping (see “Devices/ Technology”, “Personality-related aspects“ and “Other boundary conditions” in Figure 5). It is still unclear under which circumstances (e.g. where, who and when) AR can provide a superior or inferior shopping experience in terms of affective, cognitive, social, and behavioral outcomes. For example, the empirical evidence from Xi *et al.* (2021) revealed that a fully physical environment or the combination of AR and VR can provide better memory performance during shopping than using AR alone; AR might not be suitable for a certain group of shoppers given that it is associated with certain perceptual and cognitive skills (Peleg-Adler *et al.*, 2018); under a high level of chronic time pressure, users might have difficulty being engaged in activities due to fatigue and tension (Kim and Kim, 2008). Therefore, situational factors and individual factors such as age, gender, education, prior AR experience, personality, cultural factors, immersive tendency might also influence AR shopping experiences and should be considered as potential moderating variables.

Agenda point 5: Explore the boundary conditions of AR shopping.

5.3.2 Theoretical agenda. As revealed in Section 4.4., the by far most considerably employed theory to explore the adoption of AR in shopping contexts has been the technology acceptance model. This is not surprising, because this theory has proved over time to be a reliable source for explaining the adoption of information systems across a multitude of disciplines. Research is still in an early phase in terms of investigating the interaction of humans with AR, and this technology is likely to become even more prevalent in our lives. Thus, there will be new contexts, new types of products, more diverse user groups, and new technological features in the future which requires research to explore these developments based on more diverse theories. For example, as mentioned earlier (see Agenda point 3 and the social experience subsumed under “Psychological outcomes” in Figure 5), social features may become more relevant in future AR shopping systems, and thus, we need to employ appropriate social theories more often that can help explain the adoption and use behaviors based on the social features in the system. This is just one example and different developments require different theoretical perspectives. Therefore, there is a need to veer towards more diverse theories that may be appropriate for these and other contemporary developments. On the other hand, apart from the technology acceptance model, most of the encountered theories have been employed only to a very limited extent within the body of reviewed literature (the majority of theories were encountered only once). Therefore, besides exploring a diverse spectrum of theories, it seems necessary that future AR research also commits to validating already but only sparingly employed theories further to verify previous results.

Agenda point 6: Explore more diverse theories to assimilate with contemporary developments and validate infrequently employed theories to verify unpolished findings.

Prior research indicates that AR can result in heightened workload and perceptual challenges because users are exposed to multiple realities (i.e. the augmented and the physical reality), which have to be mentally combined (Xi *et al.*, 2022). Our review draws a somewhat ambivalent picture with regard to the cognitive exertion of users during AR shopping. On the one hand, it was argued that AR can potentially heighten the cognitive load of users (e.g. Tarafdar *et al.*, 2019) while on the other, it was also discovered that AR can reduce cognitive load, for example, via helping users mentally in imagining products (Heller *et al.*, 2019a). These studies represent important contributions to understanding the phenomenon of cognitive support and demand in AR better, but ultimately, there is still much to learn in this matter. Specifically, future research should seek to gain a more accurate understanding about the particular AR features that may support or impede cognitive load, if there are certain product types that can be cognitively processed better or worse, if certain personality-related aspects may be predictors for high or low cognitive exertion and so on. Essentially, there still seems to be a great deal of uncertainty on these issues, and considering that some of the findings in the current literature draw different pictures on the mental effort of using AR, it seems important that research continues to employ cognitive theories in order to get to the bottom of the circumstances under which AR supports or impedes users' cognitive exertion.

Agenda point 7: Explore the ambivalent picture of cognitive load during AR shopping.

One aspect that may lead to higher cognitive exertion but also to higher informativeness is the degree of information. The reviewed studies mostly focused on how AR can increase informativeness and reduce product fit uncertainties through its basic features (e.g. interactivity and vividness) (refer to the relationship between "AR technology characteristics" and "Psychological outcomes" in Figure 5). AR applications usually solely display the virtual product without any additional information. Considering that most online shops provide crucial information, such as star ratings and product reviews, it is surprising that most AR applications lack such informational cues while products are virtually presented. Instead, users commonly have to close out of the AR view to attain additional information about a product, which can greatly inhibit the usability of AR systems. However, we expect that the benefit of superimposing information in addition to virtual products comes at the cost of heightened cognitive effort, as users have to mentally combine the physical surroundings with the virtual product and now on top of that, with the additional virtual information. Little is known about the red line at which the degree of information is still acceptable to users without causing cognitive overload. Therefore, future research should investigate how different amounts of information presented in AR environments affect individuals positively (e.g. in terms of informativeness, reduced risk perceptions, decision comfort, etc.) while at the same time explore at what point users may be affected negatively in terms of cognitive overexertion, and thus benefits are outweighed by disadvantages.

Agenda point 8: Explore the relationship between cognitive load and degree of information.

5.3.3 Methodological agenda. All of the reviewed studies collected data via subjective measures (i.e. surveys) in experimental or SEM-based studies. While subjective measures are good instruments to quantify the experiences of users, we deem it important that future studies also consider different data collection methods. Specifically, data based on the physiological responses of users could be of critical essence in future studies. For example, via ocular data (e.g. eye tracking) the usability of AR shopping systems can be assessed. In addition, cardiovascular (e.g. heart rate measures) and brain data (e.g. electroencephalographic measures) could be potential ways to assess the experience of users when engaging in AR shopping. Since in the current literature the cognitive processes of consumers during AR shopping have been of major interest, it could be an especially important addition to the scientific literature if results based on subjective measures are further validated with brain measures in future studies. Besides electroencephalographic measures, this can include functional magnetic resonance imaging or positron emission tomography, which are measures that can bring light into the cognitive processes of users and which have previously been argued to be suitable to assess the mental activity, performance, and workload of individuals (Tsang and Vidulich, 2006).

Agenda point 9: Explore physiological data collection methods.

The reviewed literature almost exclusively investigated AR shopping via point-in-time data and while such methods are fitting to provide a snapshot of user perceptions at a specific point in time, they are less suitable to observe changes over time. Therefore, there seems to be a lack of understanding regarding how user perceptions of AR shopping change over time and how to achieve long-term engagement with AR. Longitudinal studies and repeated cross-section studies may contribute to resolving some of these uncertainties because they are often considered to be more valid in terms of examining temporal developments and cause-effect relationships (Caruana *et al.*, 2015). In the present study, the analyzed literature abundantly relies on subjective measures that inquire about reuse or continued use intentions, however, actual system log data or other observational data over time that would further support these results are rare. While this is understandable, as collecting data at a specific point in time bears several advantages, such as being less costly, less time consuming and often simply more feasible to realize, we deem it important that future research also entails longitudinal studies which assess the long-term effects of AR or how perceptions of users of the technology change over time.

Agenda point 10: Explore AR shopping in longitudinal and repeated cross-section studies.

5.3.4 Technological agenda. Even though interactivity is one of the main features of AR (see "AR technology characteristics" in Figure 5), only 28.9% of the reviewed studies investigated this particular feature. Interactivity is considered to be associated with users' engagement in shopping (Yi *et al.*, 2015) and hedonic experience (Fiore *et al.*, 2005). Therefore, future inquiries should attempt to create more interactive experiences for AR shopping. For example, future research can consider developing various interactive content (e.g. video, picture, text, 3D models), designing different interactive ways (e.g. sound input and output, body movement, haptics), and applying different modalities for a multisensory interactive experience.

Agenda point 11: Explore more diverse interactive experiences of AR content.

With the exception of Heller *et al.* (2019b) who investigated AR glasses, and Morillo *et al.* (2019) who investigated a pseudo-holographic system, the examined literature analyzed AR via desktop PCs and most considerably via mobile devices (see "Devices/Technology" in

Figure 5). This is not surprising, because today's mobile devices are largely rolled out with AR capabilities and provide cost-effective access to AR technology. However, as specific AR hardware is becoming more and more affordable, it seems important to also understand the effects and criteria for the adoption of specific AR hardware. For example, AR glasses offer hands-free interaction and virtual objects are directly overlaid over the user's vision, which is different from using AR via mobile phones or tablets. Accordingly, users may perceive AR differently when using such specifically tailored AR hardware compared to mobile devices. There seems to be a lack of empirical studies that explore shopping experiences, effects, criteria for adoption, and potential detrimental effects of using dedicated AR hardware. Therefore, we call upon future research to explore these gaps.

Agenda point 12: Explore how dedicated AR hardware influences consumers' cognitive/affective responses and behavior.

Visual, auditory, tactile, olfactory, and gustatory aspects of the shopping environment can influence consumers' shopping behaviors and experiences (Spence *et al.*, 2014). However, given that the reviewed literature has been limited to understanding the optical augmentation capabilities, there is a lack of investigating multisensory experience in AR shopping. By using different multisensory modalities essentially any human senses can be exposed in an augmented way (e.g. digital scent mask, haptics, treadmill, sound, touch, smell, taste, movement, etc.). This information provided by multisensory modalities can substitute the missing product attributes or create new dimensions. For instance, haptics can be used to replace the "real" sense of touch such as texture, shape, and weight, which is beneficial for online shopping as well as luxury and expensive products whereas digital scent technology can artificially create new attributes for products that can only provide visual information. Future studies should investigate more multi-modality-based sensory experiences and the disruptive potential of AR in shopping (Rauschnabel, 2021).

Agenda point 13: Explore multimodalities in AR shopping systems and the corresponding multisensory experience.

6. Conclusion and limitations

In this literature review, we provided a holistic overview and synthesis of the empirical shopping-related AR literature from the past ten years. Based on the results of our review, we were able to cement a framework for AR induced consumer behavior in shopping as well as derive an in-depth discourse on possible future research avenues. This review is limited to literature that explores AR in the specific context of shopping as well as literature of empirical nature. Accordingly, studies that explore related technologies (e.g. VR) or contexts different from shopping as well as methodologies deviating from empirical approaches (e.g. case studies, dedicated design studies, etc.), are not represented in this review. Due to this rigorous approach in our systematic literature review, exploratory research related to AR shopping is absent from the present study. While we complied with the recommendations for performing comprehensive systematic literature reviews and although we carefully considered a variety of possible search terms, there may still be studies that analyze AR under yet other terminology, and which thus may not have been found during our search phase. In addition, we limited our search to the past 10 years as we wanted to explore the current developments and results in AR research. Therefore, findings prior to ten years ago are missing from this review. Moreover, we only reviewed articles written in English. It can be noticed that AR technology has become mature and widely used in various industries in countries such as Japan, South Korea, and China. AR related studies have been published in non-English journals and conferences. Thus, the search language can also be expanded in the future.

Nevertheless, we believe that our review provides a broad and detailed picture of the state-of-the-art research on AR shopping and paves the way for future research in the field.

References

Adam, M. and Pecorelli, M. (2018), "Recommendations in augmented reality applications – the effect of customer reviews and seller recommendations on purchase intention and product selection", *Twenty-Sixth European Conference on Information Systems (ECIS)*, Portsmouth.

Adams, J.S. (1963), "Toward an understanding of inequity", *Journal of Abnormal Psychology*, Vol. 67, pp. 422-436, doi: 10.1037/h0040968.

Albert, A., Hallowell, M.R., Kleiner, B., Chen, A. and Golparvar-Fard, M. (2014), "Enhancing construction hazard recognition with high-fidelity augmented virtuality", *Journal of Construction Engineering and Management*, Vol. 140 No. 7, 4014024, doi: 10.1061/(ASCE)CO.1943-7862.0000860.

Alter, A.L. and Oppenheimer, D.M. (2009), "Uniting the tribes of fluency to form a metacognitive nation", *Personality and Social Psychology Review: An Official Journal of the Society for Personality and Social Psychology, Inc*, Vol. 13 No. 3, pp. 219-235, doi: 10.1177/1088868309341564.

Azuma, R.T. (1997), "A survey of augmented reality", *Presence: Teleoperators and Virtual Environments*, Vol. 6 No. 4, pp. 355-385, doi: 10.1162/pres.1997.6.4.355.

Beck, M. and Crié, D. (2018), "I virtually try it... I want it! Virtual fitting room: a tool to increase on-line and off-line exploratory behavior, patronage and purchase intentions", *Journal of Retailing and Consumer Services*, Vol. 40, pp. 279-286, doi: 10.1016/j.jretconser.2016.08.006.

Bonnin, G. (2020), "The roles of perceived risk, attractiveness of the online store and familiarity with AR in the influence of AR on patronage intention", *Journal of Retailing and Consumer Services*, Vol. 52, 101938, doi: 10.1016/j.jretconser.2019.101938.

Brengman, M., Willems, K. and van Kerrebroeck, H. (2019), "Can't touch this: the impact of augmented reality versus touch and non-touch interfaces on perceived ownership", *Virtual Reality*, Vol. 23 No. 3, pp. 269-280, doi: 10.1007/s10055-018-0335-6.

Brereton, P., Kitchenham, B.A., Budgen, D., Turner, M. and Khalil, M. (2007), "Lessons from applying the systematic literature review process within the software engineering domain", *Journal of Systems and Software*, Vol. 80 No. 4, pp. 571-583, doi: 10.1016/j.jss.2006.07.009.

Brown, J.S., Collins, A. and Duguid, P. (1989), "Situated cognition and the culture of learning", *Educational Researcher*, Vol. 18 No. 1, pp. 32-42, doi: 10.3102/0013189X018001032.

Caboni, F. and Hagberg, J. (2019), "Augmented reality in retailing: a review of features, applications and value", *International Journal of Retail and Distribution Management*, Vol. 47 No. 11, pp. 1125-1140, doi: 10.1108/IJRDM-12-2018-0263.

Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E. and Ivkovic, M. (2011), "Augmented reality technologies, systems and applications", *Multimedia Tools and Applications*, Vol. 51 No. 1, pp. 341-377, doi: 10.1007/s11042-010-0660-6.

Caruana, E.J., Roman, M., Hernández-Sánchez, J. and Solli, P. (2015), "Longitudinal studies", *Journal of Thoracic Disease*, Vol. 7 No. 11, pp. E537-E540, doi: 10.3978/j.issn.2072-1439.2015.10.63.

Chen, P., Peng, Z., Li, D. and Yang, L. (2016), "An improved augmented reality system based on and AR", *Journal of Visual Communication and Image Representation*, Vol. 37 No. 7, pp. 63-69, doi: 10.1016/j.jvcir.2015.06.016.

Cheng, K.-H. and Tsai, C.-C. (2014), "Children and parents' reading of an augmented reality picture book: analyses of behavioral patterns and cognitive attainment", *Computers and Education*, Vol. 72 No. 2, pp. 302-312, doi: 10.1016/j.compedu.2013.12.003.

Choi, U. and Choi, B. (2020), "The effect of augmented reality on consumer learning for search and experience products in mobile commerce", *Cyberpsychology, Behavior and Social Networking*, Vol. 23 No. 11, pp. 800-805, doi: 10.1089/cyber.2020.0057.

Cowan, K., Javornik, A. and Jiang, P. (2021), "Privacy concerns when using augmented reality face filters? Explaining why and when use avoidance occurs", *Psychology and Marketing*, Vol. 38 No. 10, pp. 1799-1813, doi: 10.1002/mar.21576.

Dacko, S.G. (2017), "Enabling smart retail settings via mobile augmented reality shopping apps", *Technological Forecasting and Social Change*, Vol. 124, pp. 243-256, doi: 10.1016/j.techfore.2016.09.032.

Daft, R.L. and Lengel, R.H. (1986), "Organizational information requirements, media richness and structural design", *Management Science*, Vol. 32 No. 5, pp. 554-571, doi: 10.1287/mnsc.32.5.554.

Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol. 13 No. 3, pp. 319-340, doi: 10.2307/249008.

Deci, E.L. and Ryan, R.M. (2010), "Intrinsic motivation", in Weiner, I.B. and Craighead, W.E. (Eds), *The Corsini Encyclopedia of Psychology*, John Wiley and Sons, Hoboken, New Jersey, Vol. 125, p. 627. doi: 10.1002/9780470479216.corpsy0467.

Díaz-Martín, A.M., Quinones, M. and Cruz-Roche, I. (2021), "The post-COVID-19 shopping experience: thoughts on the role of emerging retail technologies", in Rocha, Á., Reis, J.L., Peter, M.K., Cayolla, R., Loureiro, S. and Bogdanović, Z. (Eds), *Marketing and Smart Technologies, Smart Innovation, Systems and Technologies*, Springer, Singapore, Vol. 205, pp. 55-67, doi: 10.1007/978-981-33-4183-8_6.

Dinev, T. and Hart, P. (2006), "An extended privacy calculus model for E-commerce transactions", *Information Systems Research*, Vol. 17 No. 1, pp. 61-80, doi: 10.1287/isre.1060.0080.

Easterbrook, J.A. (1959), "The effect of emotion on cue utilization and the organization of behavior", *Psychological Review*, Vol. 66 No. 3, pp. 183-201, doi: 10.1037/h0047707.

Fan, X., Chai, Z., Deng, N. and Dong, X. (2020), "Adoption of augmented reality in online retailing and consumers' product attitude: a cognitive perspective", *Journal of Retailing and Consumer Services*, Vol. 53, 101986, doi: 10.1016/j.jretconser.2019.101986.

Fiore, A.M., Jin, H.-J. and Kim, J. (2005), "For fun and profit: hedonic value from image interactivity and responses toward an online store", *Psychology and Marketing*, Vol. 22 No. 8, pp. 669-694, doi: 10.1002/mar.20079.

Flavián, C., Ibáñez-Sánchez, S. and Orús, C. (2019), "The impact of virtual, augmented and mixed reality technologies on the customer experience", *Journal of Business Research*, Vol. 100 No. 4, pp. 547-560, doi: 10.1016/j.jbusres.2018.10.050.

Friston, K.J. (2018), "Active inference and cognitive consistency", *Psychological Inquiry*, Vol. 29 No. 2, pp. 67-73, doi: 10.1080/1047840X.2018.1480693.

Galar, D. and Kumar, U. (2017), *eMaintenance: Essential Electronic Tools for Efficiency*, Academic Press, s.l.

Haile, T.T. and Kang, M. (2020), "Mobile augmented reality in electronic commerce: investigating user perception and purchase intent amongst educated young adults", *Sustainability*, Vol. 12 No. 21, p. 9185, doi: 10.3390/su12219185.

Hamari, J., Malik, A., Koski, J. and Johri, A. (2019), "Uses and gratifications of pokémon go: why do people play mobile location-based augmented reality games?", *International Journal of Human–Computer Interaction*, Vol. 35 No. 9, pp. 804-819, doi: 10.1080/10447318.2018.1497115.

Handarkho, Y.D. (2020), "Impact of social experience on customer purchase decision in the social commerce context", *Journal of Systems and Information Technology*, Vol. 22 No. 1, pp. 47-71, doi: 10.1108/JSIT-05-2019-0088.

Heller, J., Chylinski, M., de Ruyter, K., Mahr, D. and Keeling, D.I. (2019a), "Let me imagine that for you: transforming the retail frontline through augmenting customer mental imagery ability", *Journal of Retailing*, Vol. 95 No. 2, pp. 94-114, doi: 10.1016/j.jretai.2019.03.005.

Heller, J., Chylinski, M., de Ruyter, K., Mahr, D. and Keeling, D.I. (2019b), "Touching the untouchable: exploring multi-sensory augmented reality in the context of online retailing", *Journal of Retailing*, Vol. 95 No. 4, pp. 219-234, doi: 10.1016/j.jretai.2019.10.008.

Hilken, T., de Ruyter, K., Chylinski, M., Mahr, D. and Keeling, D.I. (2017), "Augmenting the eye of the beholder: exploring the strategic potential of augmented reality to enhance online service experiences", *Journal of the Academy of Marketing Science*, Vol. 45 No. 6, pp. 884-905, doi: 10.1007/s11747-017-0541-x.

Hilken, T., Keeling, D.I., de Ruyter, K., Mahr, D. and Chylinski, M. (2020), "Seeing eye to eye: social augmented reality and shared decision making in the marketplace", *Journal of the Academy of Marketing Science*, Vol. 48 No. 2, pp. 143-164, doi: 10.1007/s11747-019-00688-0.

Huang, T.-L. (2019), "Psychological mechanisms of brand love and information technology identity in virtual retail environments", *Journal of Retailing and Consumer Services*, Vol. 47, pp. 251-264, doi: 10.1016/j.jretconser.2018.11.016.

Huang, T.-L. and Liao, S. (2015), "A model of acceptance of augmented-reality interactive technology: the moderating role of cognitive innovativeness", *Electronic Commerce Research*, Vol. 15 No. 2, pp. 269-295, doi: 10.1007/s10660-014-9163-2.

Huang, T.-L. and Liao, S.-L. (2017), "Creating E-shopping multisensory flow experience through augmented-reality interactive technology", *Internet Research*, Vol. 27 No. 2, pp. 449-475, doi: 10.1108/IntR-11-2015-0321.

Huang, Y., Jiang, Z., Liu, Y. and Wang, Y. (2011), "Augmented reality in exhibition and entertainment for the public", in Furht, B. (Ed.), *Handbook of Augmented Reality*, Springer, New York, NY, Vol. 6, pp. 707-720. doi: 10.1007/978-1-4614-0064-6\textunderscore.

Javornik, A. (2016), "'It's an illusion, but it looks real!' Consumer affective, cognitive and behavioural responses to augmented reality applications", *Journal of Marketing Management*, Vol. 32 No. 9-10, pp. 987-1011, doi: 10.1080/0267257X.2016.1174726.

Javornik, A., Rogers, Y., Moutinho, A.M. and Freeman, R. (2016), Revealing the shopper experience of using A 'magic mirror' augmented reality make-up application, *DIS'16: 2016 ACM Conference on Designing Interactive Systems*, Brisbane.

Jessen, A., Hilken, T., Chylinski, M., Mahr, D., Heller, J., Keeling, D.I. and de Ruyter, K. (2020), "The playground effect: how augmented reality drives creative customer engagement", *Journal of Business Research*, Vol. 116 No. 1, pp. 85-98, doi: 10.1016/j.jbusres.2020.05.002.

Katz, E., Blumler, J.G. and Gurevitch, M. (1973), "Uses and gratifications research", *The Public Opinion Quarterly*, Vol. 37 No. 4, pp. 509-523.

Kim, H.-Y. and Kim, Y.-K. (2008), "Shopping enjoyment and store shopping modes: the moderating influence of chronic time pressure", *Journal of Retailing and Consumer Services*, Vol. 15 No. 5, pp. 410-419, doi: 10.1016/j.jretconser.2007.10.003.

Kitchenham, B. (2004), *Procedures for Performing Systematic Reviews*, Keele University, Keele, Vol. 33, pp. 1-26.

Kowalczuk, P., Siepmann, C. and Adler, J. (2021), "Cognitive, affective, and behavioral consumer responses to augmented reality in e-commerce: a comparative study", *Journal of Business Research*, Vol. 124 No. 2, pp. 357-373, doi: 10.1016/j.jbusres.2020.10.050.

Krishnamurthy, V. (2016), *Partially Observed Markov Decision Processes: From Filtering to Controlled Sensing*, Cambridge University Press, Cambridge. doi: 10.1017/CBO9781316471104.

Kuiper, N.A. and Rogers, T.B. (1979), "Encoding of personal information: self-other differences", *Journal of Personality and Social Psychology*, Vol. 37 No. 4, pp. 499-514, doi: 10.1037/0022-3514.37.4.499.

Laato, S., Hyrynsalmi, S., Rauti, S., Islam, A.N. and Laine, T.H. (2020), "Location-based games as exergames – from pokémon to the wizarding world", *International Journal of Serious Games*, Vol. 7 No. 1, pp. 79-95, doi: 10.17083/ijsg.v7i1.337.

Lele, A. and Shaw, N. (2021), "Augmented reality: does it encourage customer loyalty?", in Nah, F.F.-H. and Siau, K. (Eds), *HCI in Business, Government and Organizations, Lecture Notes in Computer Science*, Springer International Publishing, Cham, Vol. 12783, pp. 105-119. doi: 10.1007/978-3-030-77750-0_7.

Ley, D. (2010), "Emerging technologies for learning", in Parkes, D. and Walton, G. (Eds), *Web 2.0 and Libraries: Impacts, Technologies and Trends*, Chandos Information Professional Series, Chandos Pub, Oxford, Vol. 39, pp. 123-168, doi: 10.1016/B978-1-84334-346-2.50006-5.

Lu, Y. and Smith, S. (2010), "Augmented reality e-commerce system: a case study", *Journal of Computing and Information Science in Engineering*, Vol. 10 No. 2, doi: 10.1115/1.3385795.

Lutz, K.A. and Lutz, R.J. (1978), "Imagery-eliciting strategies: review and implications of research", *Advances in Consumer Research*, Vol. 5 No. 1, pp. 611-620.

Masood, T. and Egger, J. (2019), "Augmented reality in support of industry 4.0 – implementation challenges and success factors", *Robotics and Computer-Integrated Manufacturing*, Vol. 58, pp. 181-195.

Massetti, B. (1996), "An empirical examination of the value of creativity support systems on idea generation", *MIS Quarterly*, Vol. 20 No. 1, pp. 83-97, doi: 10.2307/249543.

Mayer, R.E. and Moreno, R. (2003), "Nine ways to reduce cognitive load in multimedia learning", *Educational Psychologist*, Vol. 38 No. 1, pp. 43-52, doi: 10.1207/S15326985EP3801\textunderscore.

McLean, G. and Wilson, A. (2019), "Shopping in the digital world: examining customer engagement through augmented reality mobile applications", *Computers in Human Behavior*, Vol. 101, pp. 210-224, doi: 10.1016/j.chb.2019.07.002.

Mennecke, B.E., Valacich, J.S. and Wheeler, B.C. (2000), "The effects of media and task on user performance: a test of the task-media fit hypothesis", *Group Decision and Negotiation*, Vol. 9 No. 6, pp. 507-529, doi: 10.1023/A:1008770106779.

Mishra, A., Shukla, A., Rana, N.P. and Dwivedi, Y.K. (2021), "From 'touch' to a 'multisensory' experience: the impact of technology interface and product type on consumer responses", *Psychology and Marketing*, Vol. 38 No. 3, pp. 385-396, doi: 10.1002/mar.21436.

Morillo, P., Orduña, J.M., Casas, S. and Fernández, M. (2019), "A comparison study of AR applications versus pseudo-holographic systems as virtual exhibitors for luxury watch retail stores", *Multimedia Systems*, Vol. 25 No. 4, pp. 307-321, doi: 10.1007/s00530-019-00606-y.

Moriuchi, E., Landers, V.M., Colton, D. and Hair, N. (2020), "Engagement with chatbots versus augmented reality interactive technology in e-commerce", *Journal of Strategic Marketing*, Vol. 105 No. 11, pp. 1-15, doi: 10.1080/0965254X.2020.1740766.

Morschheuser, B., Riar, M., Hamari, J. and Maedche, A. (2017), "How games induce cooperation? A study on the relationship between game features and we-intentions in an augmented reality game", *Computers in Human Behavior*, Vol. 77, pp. 169-183, doi: 10.1016/j.chb.2017.08.026.

Nakamura, J. and Csikszentmihalyi, M. (2014), "The concept of flow", in Csikszentmihalyi, M. (Ed.), *Flow and the Foundations of Positive Psychology*, Springer, Dordrecht, Vol. 4, pp. 239-263, doi: 10.1007/978-94-017-9088-8\textunderscore.

Pantano, E., Rese, A. and Baier, D. (2017), "Enhancing the online decision-making process by using augmented reality: a two country comparison of youth markets", *Journal of Retailing and Consumer Services*, Vol. 38, pp. 81-95, doi: 10.1016/j.jretconser.2017.05.011.

Papagiannis, H. (2020), How AR is redefining retail in the pandemic, available at: https://hbr.org/2020/10/how-ar-is-redefining-retail-in-the-pandemic (accessed 12 November 2021).

Park, M. and Yoo, J. (2020), "Effects of perceived interactivity of augmented reality on consumer responses: a mental imagery perspective", *Journal of Retailing and Consumer Services*, Vol. 52, 101912, doi: 10.1016/j.jretconser.2019.101912.

Peleg-Adler, R., Lanir, J. and Korman, M. (2018), "The effects of aging on the use of handheld augmented reality in a route planning task", *Computers in Human Behavior*, Vol. 81 No. 6, pp. 52-62, doi: 10.1016/j.chb.2017.12.003.

Pengcheng, F., Mingquan, Z. and Xuesong, W. (2011), "The significance and effectiveness of augmented reality in experimental education", *2011 International Conference on E-Business*, pp. 1-4, doi: 10.1109/ICEBEG.2011.5881654.

Perea y Monsuwé, T., Dellaert, B.G. and de Ruyter, K. (2004), "What drives consumers to shop online? A literature review", *International Journal of Service Industry Management*, Vol. 15 No. 1, pp. 102-121, doi: 10.1108/09564230410523358.

Pilote, B. and Chiniara, G. (2019), "The many faces of simulation", *Clinical Simulation*, Elsevier, Vol. 35, pp. 17-32, doi: 10.1016/B978-0-12-815657-5.00002-4.

Pine, J.B. and Gilmore, J.H. (1998), "Welcome to the experience economy", *Harvard Business Review*, Vol. 76 No. 4, pp. 97-106.

Poushneh, A. (2018), "Augmented reality in retail: a trade-off between user's control of access to personal information and augmentation quality", *Journal of Retailing and Consumer Services*, Vol. 41, pp. 169-176, doi: 10.1016/j.jretconser.2017.12.010.

Poushneh, A. and Vasquez-Parraga, A.Z. (2017), "Discernible impact of augmented reality on retail customer's experience, satisfaction and willingness to buy", *Journal of Retailing and Consumer Services*, Vol. 34, pp. 229-234, doi: 10.1016/j.jretconser.2016.10.005.

Qin, H., Osatuyi, B. and Xu, L. (2021a), "How mobile augmented reality applications affect continuous use and purchase intentions: a cognition-affect-conation perspective", *Journal of Retailing and Consumer Services*, Vol. 63, 102680, doi: 10.1016/j.jretconser.2021.102680.

Qin, H., Peak, D.A. and Prybutok, V. (2021b), "A virtual market in your pocket: how does mobile augmented reality (mar) influence consumer decision making?", *Journal of Retailing and Consumer Services*, Vol. 58 No. 4, 102337, doi: 10.1016/j.jretconser.2020.102337.

Rauschnabel, P.A. (2021), "Augmented reality is eating the real-world! The substitution of physical products by holograms", *International Journal of Information Management*, Vol. 57 No. 4, 102279, doi: 10.1016/j.ijinfomgt.2020.102279.

Rauschnabel, P.A., He, J. and Ro, Y.K. (2018), "Antecedents to the adoption of augmented reality smart glasses: a closer look at privacy risks", *Journal of Business Research*, Vol. 92, pp. 374-384, doi: 10.1016/j.jbusres.2018.08.008.

Rese, A., Baier, D., Geyer-Schulz, A. and Schreiber, S. (2017), "How augmented reality apps are accepted by consumers: a comparative analysis using scales and opinions", *Technological Forecasting and Social Change*, Vol. 124, pp. 306-319, doi: 10.1016/j.techfore.2016.10.010.

Riar, M., Korbel, J.J., Xi, N., Zarnekow, R. and Hamari, J. (2021), "The use of augmented reality in retail: a review of literature", *Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS)*, Hawaii, pp. 638-647, doi: 10.24251/HICSS.2021.078.

Riar, M., Morschheuser, B., Hamari, J. and Zarnekow, R. (2020), "How game features give rise to altruism and collective action? Implications for cultivating cooperation by gamification", *Proceedings of the 53rd Hawaii International Conference on System Sciences (HICSS)*, Hawaii, pp. 695-704, doi: 10.24251/HICSS.2020.086.

Rintamäki, T., Kanto, A., Kuusela, H. and Spence, M.T. (2006), "Decomposing the value of department store shopping into utilitarian, hedonic and social dimensions", *International Journal of Retail and Distribution Management*, Vol. 34 No. 1, pp. 6-24, doi: 10.1108/09590550610642792.

Ryu, S. and Park, J. (2020), "The effects of benefit-driven commitment on usage of social media for shopping and positive word-of-mouth", *Journal of Retailing and Consumer Services*, Vol. 55 No. 1, 102094, doi: 10.1016/j.jretconser.2020.102094.

Saprikis, V., Avlogiaris, G. and Katarachia, A. (2021), "Determinants of the intention to adopt mobile augmented reality apps in shopping malls among university students", *Journal of Theoretical* *and Applied Electronic Commerce Research*, Vol. 16 No. 3, pp. 491-512, doi: 10.3390/jtaer16030030.

Sawyer, A. (1982), "Repetition, cognitive responses and persuasion", in Petty, R., Ostrom, T.M. and Brock, T.C. (Eds), *Cognitive Responses in Persuasion*, Lawrence Erlbaum Associates, Hillsdale, New Jersey, pp. 237-262.

Schwarz, N. (2012), "Feelings-as-Information theory", in van Lange, P., Kruglanski, A. and Higgins, E. (Eds), *Handbook of Theories of Social Psychology*, SAGE Publications, London, Vol. 1, pp. 289-308. doi: 10.4135/9781446249215.n15.

Semin, G.R. and Smith, E.R. (2013), "Socially situated cognition in perspective", *Social Cognition*, Vol. 31 No. 2, pp. 125-146, doi: 10.1521/soco.2013.31.2.125.

Smink, A.R., Frowijn, S., van Reijmersdal, E.A., van Noort, G. and Neijens, P.C. (2019), "Try online before you buy: how does shopping with augmented reality affect brand responses and personal data disclosure", *Electronic Commerce Research and Applications*, Vol. 35, 100854, doi: 10.1016/j.elerap.2019.100854.

Smink, A.R., van Reijmersdal, E.A., van Noort, G. and Neijens, P.C. (2020), "Shopping in augmented reality: the effects of spatial presence, personalization and intrusiveness on app and brand responses", *Journal of Business Research*, Vol. 118 No. 2, pp. 474-485, doi: 10.1016/j.jbusres.2020.07.018.

Spence, C., Puccinelli, N.M., Grewal, D. and Roggeveen, A.L. (2014), "Store atmospherics: a multisensory perspective", *Psychology and Marketing*, Vol. 31 No. 7, pp. 472-488, doi: 10.1002/mar.20709.

Spreer, P. and Kallweit, K. (2014), "Augmented reality in retail: assessing the acceptance and potential for multimedia product presentation at the PoS", *Transactions on Marketing Research*, Vol. 1 No. 1, pp. 20-35.

Steuer, J. (1992), "Defining virtual reality: dimensions determining telepresence", *Journal of Communication*, Vol. 42 No. 4, pp. 73-93, doi: 10.1111/j.1460-2466.1992.tb00812.x.

Sweller, J. and Chandler, P. (1991), "Evidence for cognitive load theory", *Cognition and Instruction*, Vol. 8 No. 4, pp. 351-362, doi: 10.1207/s1532690xci0804\textunderscore.

Tabbakh, S.R.K., Habibi, R. and Vafadar, S. (2015), "Design and implementation of a framework based on augmented reality for phobia treatment applications", *2015 International Congress on Technology, Communication and Knowledge (ICTCK)*, Mashhad, IEEE, pp. 366-370, doi: 10.1109/ICTCK.2015.7582697.

Tarafdar, P., Leung, A., Yue, W.T. and Bose, I. (2019), "Impact of immersive interface design on consumer perceptions during online product presentation", *Fortieth International Conference on Information Systems (ICIS)*, Munich.

Tsang, P.S. and Vidulich, M.A. (2006), "Mental workload and situation awareness", in Salvendy, G. (Ed.), *Handbook of Human Factors and Ergonomics*, John Wiley and Sons, Hoboken, New Jersey, pp. 243-268, doi: 10.1002/0470048204.ch9.

van Esch, P., Arli, D., Gheshlaghi, M.H., Andonopoulos, V., von der Heidt, T. and Northey, G. (2019), "Anthropomorphism and augmented reality in the retail environment", *Journal of Retailing and Consumer Services*, Vol. 49, pp. 35-42, doi: 10.1016/j.jretconser.2019.03.002.

van Krevelen, D. and Poelman, R. (2010), "A survey of augmented reality technologies, applications and limitations", *International Journal of Virtual Reality*, Vol. 19 No. 2, pp. 1-20.

Venkatesh, V., Thong, J.Y.L. and Xu, X. (2012), "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology", *MIS Quarterly*, Vol. 36 No. 1, p. 157, doi: 10.2307/41410412.

Vessey, I. (1991), "Cognitive fit: a theory-based analysis of the graphs versus tables literature", *Decision Sciences*, Vol. 22 No. 2, pp. 219-240, doi: 10.1111/j.1540-5915.1991.tb00344.x.

Wu, H.-K., Lee, S.W.-Y., Chang, H.-Y. and Liang, J.-C. (2013), "Current status, opportunities and challenges of augmented reality in education", *Computers and Education*, Vol. 62, pp. 41-49, doi: 10.1016/j.compedu.2012.10.024.

Xi, N., Chen, J., Gama, F., Korkeila, H. and Hamari, J. (2021), "The effect of operating in many realities on memory: an experiment on memory recognition in extended realities", *Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS)*, Hawaii, pp. 4486-4495, doi: 10.24251/HICSS.2021.544.

Xi, N., Chen, J., Gama, F., Riar, M. and Hamari, J. (2022), "The challenges of entering the metaverse: an experiment on the effect of extended reality on workload", *Information Systems Frontiers*, pp. 1-22, doi: 10.1007/s10796-022-10244-x.

Xi, N. and Hamari, J. (2021), "Shopping in virtual reality: a literature review and future agenda", *Journal of Business Research*, Vol. 134, pp. 37-58, doi: 10.1016/j.jbusres.2021.04.075.

Yahia, I.B., Al-Neama, N. and Kerbache, L. (2018), "Investigating the drivers for social commerce in social media platforms: importance of trust, social support and the platform perceived usage", *Journal of Retailing and Consumer Services*, Vol. 41 No. 3, pp. 11-19, doi: 10.1016/j.jretconser.2017.10.021.

Yi, C., Jiang, Z. and Benbasat, I. (2015), "Enticing and engaging consumers via online product presentations: the effects of restricted interaction design", *Journal of Management Information Systems*, Vol. 31 No. 4, pp. 213-242, doi: 10.1080/07421222.2014.1001270.

Yim, M.Y.-C., Chu, S.-C. and Sauer, P.L. (2017), "Is augmented reality technology an effective tool for e-commerce? An interactivity and vividness perspective", *Journal of Interactive Marketing*, Vol. 39, pp. 89-103, doi: 10.1016/j.intmar.2017.04.001.

Yip, J., Wong, S.-H., Yick, K.-L., Chan, K. and Wong, K.-H. (2019), "Improving quality of teaching and learning in classes by using augmented reality video", *Computers and Education*, Vol. 128 No. 1, pp. 88-101, doi: 10.1016/j.compedu.2018.09.014.

Yoo, J. (2020), "The effects of perceived quality of augmented reality in mobile commerce – an application of the information systems success model", *Informatics*, Vol. 7 No. 2, p. 14, doi: 10.3390/informatics7020014.

Zhang, T., Wang, W.Y.C., Cao, L. and Wang, Y. (2019), "The role of virtual try-on technology in online purchase decision from consumers' aspect", *Internet Research*, Vol. 29 No. 3, pp. 529-551, doi: 10.1108/IntR-12-2017-0540.

Corresponding author
Marc Riar can be contacted at: marc.riar@tu-berlin.de