Too Real for Comfort: Measuring Consumers' Augmented Reality Information Privacy Concerns

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Abstract Privacy concerns are an often cited obstacle to consumer adoption of augmented reality (AR) technology, but research has not yet developed a specific measurement scale to capture these concerns. We address this need by drawing on AR and privacy literature to develop a ten-item Augmented Reality Information Privacy Concerns (ARIPC) scale. We follow a systematic scale development process that includes an empirical application of the scale. We offer novel and practically useful insights into consumer privacy concerns towards AR as a novel technology.

Keywords Augmented reality · Privacy concerns · Privacy calculus · Scale development

1 Introduction

Across a variety of contexts, firms increasingly deploy augmented reality (AR). For instance, IKEA's AR application enables consumers to virtually re-decorate their homes; Mister Spex' virtual mirror lets consumers 'try-on' sunglasses before buying online; and KabaQ's AR menus allow restaurants to showcase their food and drinks to consumers as lifelike 3D holograms (Jessen et al., 2020; Heller et al., 2019a; Hilken et al., 2017). AR's unique ability to project virtual content into the real world offers myriad benefits to consumers. For instance, in the context of frontline retail experiences, Heller et al. (2019a) show that AR outperforms traditional media due to its ability to make product or service experiences more vivid and easier to imagine; in the advertising context AR provides more informative and visually appealing content to consumers (de Ruyter et al., 2020); and in the online shopping context AR enables consumers to feel more comfortable with their purchase decisions (Hilken et al.,

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2017). However, despite these benefits, consumer adoption of AR remains slow, such that this novel technology might not live up to its widely-heralded potential. Indeed, only a small percentage of consumers consider adopting AR apps or find them worth recommending (Dacko, 2017; Rauschnabel et al., 2017; Rese et al., 2017). A recent study by the Boston Consulting Group (2018) also shows that only one-third of smartphone users in the US regularly use AR, while Gartner (2018) predicts that AR will be relevant for the consumer market in five to ten years at the earliest. This slow uptake is also a prominent motive for investors not to pursue business opportunities in the field of AR (Perkins Coie, 2019).

The reason for this stagnant development, in part, may lie in consumers' privacy concerns towards AR (Adilin, 2020). Major data leakages, cases of data misuse, cyber-attacks, and uncertainty about new technologies' abilities to violate individual privacy (e.g., Clearview AI) have sensitized consumers to information privacy. In a recent study, one-third of participants report privacy concerns towards AR and consider these as a major obstacle to using the technology (Dacko, 2017). This is hardly suprising, as AR requires consumers to point their cameras at themselves (e.g., Snapchat or Mister Spex) or their environment (e.g., IKEA Place or Pokémon Go) and thus reveal personal information, which they might not want to share. Thus, there is a pressing managerial need for more insights into AR-related privacy concerns, and particularly for assessing these with an easy-to-use measurement approach.

Research, however, has predominantly focused on privacy concerns towards specific AR devices (e.g., smart glasses; Rauschnabel et al., 2018) or relied on adaptations of early information privacy concern scales (Hilken et al., 2017), such that currently no AR-specific privacy concern scale exists. In general, many studies of privacy concerns towards new technologies utilize scales developed more than a decade ago (e.g., Smith et al., 1996; Malhotra et al., 2004). Yet, even the authors of these early scales themselves assert that measurement scales are "neither absolute nor static, since perceptions of advocates, consumers, and scholars could shift over time" (Smith et al., 1996, p. 190), thus stressing the transient validity of privacy scales. We thus believe it is crucial to develop a contemporary privacy concern scale for AR to gain insights into which factors might keep consumers from using this novel technology. Such a scale must consider both AR's unique features and the fact that consumers nowadays engage in a so-called privacy calculus, weighing the benefits and risks of use, before adopting new technology (Culnan & Armstrong, 1999; Martin & Murphy, 2017).

Following the call for more research on consumer privacy concerns (Martin & Murphy, 2017), we develop the Augmented Reality Information Privacy Concerns (ARIPC) scale. In doing so, we make three main contributions. First, drawing on privacy and AR literature, we identify a number of underlying dimensions for consumers' privacy concerns towards AR. These include both adaptions of established concerns (Collection, Transparency, and Control) as well as three novel AR-specific concerns (Unwanted Exposure, Bias Perception of Reality, and Contextualized Marketing). Furthermore, in line with social exchange (SE) theory and the notion of a privacy calculus, we propose a novel approach to measuring consumer privacy concerns by asking respondents to weigh the benefits against the privacy-related risks of using the technology. Second, we follow a systematic scale development approach to develop a ten-item ARIPC scale, which provides researchers and managers with an easy-to-use scale to measure AR-specific privacy concerns. Third, we offer an empirical application of the scale, showing that consumers' ARIPC negatively impact their cognitive and emotional engagement with AR as well as subsequent behavioural intentions (WOM and usage). In sum, this research offers much-needed insights into—and recommendations for managing—consumers' AR-related privacy concerns.

2 Theoretical Development

2.1 Existing Conceptualizations and Scales of Privacy Concerns

The complexity and contextual dependencies of the privacy concept have led to various definitions across time and contexts (Martin & Murphy, 2017). In this research, we focus on so-called information privacy, which is distinct from physical privacy and is defined as "the ability (i.e., capacity) of the individual to control personally […] information about one's self" (Stone et al., 1983, p. 460). AR applications typically scan and modify the consumer directly (e.g., virtual try-on of L'Oreal makeup), their surroundings (e.g., IKEA furniture holograms), or others within these surroundings (e.g., shared Snapchat filters). AR thus holds significant potential to cause concerns about personal information related to the self, surroundings, and bystanders, which motivates us to base our theorizing on this control-oriented definition of privacy.

The inherent contradiction between AR's reliance on personal information and the fact that consumers with privacy concerns do not see themselves in a position where they are in control of their information poses challenges. Malhotra et al. (2004) posit that the legitimate or illegitimate collection of personal data "is the starting point of various information privacy concerns" (Malhotra et al., 2004, p. 338). By evoking feelings of uncertainty and vulnerability (Barney & Hansen, 1994), information privacy concerns reduce the perceived trustworthiness of a technology and create psychological barriers to using it (Rauschnabel et al., 2018). This lack of trust has frequently inhibited consumer adoption of new technologies, thus prompting researchers to operationalize and measure consumer privacy concerns. The three most prominent measurement scales are: Concerns for Information Privacy (CFIP) by Smith et al. (1996); Internet Users' Information Privacy Concerns (IUIPC) by Malhotra et al. (2004); and Mobile Users' Information Privacy Concerns (MUIPC) by Xu et al. (2012). While all three scales have progressed insights into consumer privacy concerns about new technologies, they fall short in addressing the unique technological and social implications of AR. We thus use these scales as a starting point for our scale development of an AR-specific privacy concern scale.

2.2 Theoretical Foundations of the ARIPC Scale

To explore consumers' information privacy concerns towards AR, we conducted a semi-structured focus group interview with six graduate business students from a Dutch university. We introduced participants to AR and let them familiarize themselves with various applications (i.e., IKEA Place app, L'Oréal and Mr. Spex virtual mirrors). Participants then answered questions about their experience, concerns, and intentions regarding AR. We encouraged participants to directly respond to their peers' remarks to reveal both points of consensus and disagreement. The session was recorded and independently transcribed by two researchers. The findings revealed that today's consumers have resigned from the illusion of being in control of their data. Participants agreed that trying to conceal personal information may be ineffective due to the manifold data-gathering techniques. Most importantly, participants also reported that experiencing the benefits of new technologies without sacrificing information privacy is likely not possible in today's digitally connected world. This behavioural contradiction, called the "personalisation/privacy paradox", has received increasing attention in the literature (Aguirre et al., 2015), and is based on the human tendency to heavily discount future events (i.e., costs of giving up personal data) and to focus on immediate benefits (i.e., reward one gets in exchange for a piece of information). As a result, although consumers are concerned about their privacy, they willingly provide their personal information to companies, for example, when the benefits of data-intensive applications seem to outweigh the risks (Smith et al., 2011). Participants also reported that they base their decision, whether to use AR or not, on the related costs and benefits. While data provision is seen as a cost, the visualization of products in the users' surroundings when using AR is considered as the main benefit.

Social exchange (SE) theory explains the rules for the bilateral exchange of resources, which are thought to provide benefits to the exchange partner (White, 2004). SE theory has thus proven particularly useful in investigating relationships based on costs and benefits as perceived by consumers (Martin & Murphy, 2017). The parties involved in an exchange aim to maximize benefits and only provide resources (i.e., they only incur costs) when they expect a net gain (White, 2004). Thus, in the context of information privacy, consumers are willing to participate in a social exchange by revealing personal information if the perceived benefits exceed, or at least compensate for, the perceived costs (Culnan & Armstrong, 1999; Martin & Murphy, 2017).

In the context of AR, SE theory suggests that the exchange is only balanced, when the benefits of using AR, such as the ability to customise (Carrozzi et al., 2019) or creatively engage (Jessen et al., 2020) with products and facilitate decision making (Hilken et al., 2020), outweigh the various costs and risks of giving up personal information, leading consumers to act contrary to their information privacy concerns. The aggregated costs consumers associate with AR use are the AR-specific privacy concerns, which we seek to measure in this research. The social exchange is imbalanced when a company harms the consumer by violating the reciprocity, increasing the individuals' costs, and its own benefits. Culnan and Armstrong (1999) label the rational assessment of costs and benefits regarding the disclosure of personal information as a transaction privacy calculus. Therefore, we design the ARIPC scale in a way that captures the AR cost-benefit trade-off, providing companies with the means to measure which particular privacy concerns outweigh the benefits, and, in turn, would lead consumers to not use the technology.

2.3 Dimensions of the ARIPC Scale

On the basis of our review of existing scales in the literature, enriched by the insights from the focus group interview and the theoretical foundation of SE theory, we identify seven potential dimensions for the ARIPC scale. Four dimensions are captured by existing scales: Collection, Transparency, and Control from the IUIPC scale by Malhotra et al. (2004), and Perceived Surveillance from the MUIPC scale by Xu et al. (2012). In addition we propose the following three AR-specific dimensions.

First, *Unwanted (Social/Economic) Exposure* captures consumers' concerns about being exposed due to their use of AR. Feelings of vulnerability are fostered not only because of the information consumers reveal about themselves when using AR, but also because of the implicit information and interpretations about their social and economic background that can be drawn based upon this information. Therefore, this ARIPC dimension goes beyond the MUIPC's dimension of Perceived Intrusion (Xu et al., 2012). For instance, users of the IKEA Place app might not feel comfortable with revealing their taste in furniture because it could be labelled as embarrassing in their social reference group (i.e., Unwanted Social Exposure); they might also not want other people to interpret their economic situation based on the prices of virtual furniture they choose (i.e., Unwanted Economic Exposure).

Second, as AR digitally transforms the real world by projecting virtual content into the physical environment, consumers could be concerned about a biasing effect on their perception of reality (i.e., *Perception Bias of Reality*). Prior research has demonstrated that AR can shift the perceptions of users about their own appearance or body image (Yim & Park, 2019). This effect is illustrated by beauty-enhancing Snapchat filters, which have recently gained media attention surrounding the phenomenon of "Snapchat Dysmorphia" (The Guardian, 2019), where the criteria of a person's beauty perception experiences a shift towards the ideals of beauty promoted by face-filters when regularly confronted with them. The logic can easily be extended to consumer concerns about AR applications altering their physical environment, for instance by displaying only certain (branded) products or biasing their decision making with by visually enhancing certain information in the real world.

Third, *Contextualized Marketing* addresses consumers' concerns about the potential extraction of personal information from their use of AR and subsequent information processing for targeted marketing purposes. After all, AR applications rely on visual detection features that scan the consumer or their environment (Chylinski et al., 2020), and they also track which AR-content a consumer has viewed—both of which can provide marketers with novel personalised marketing opportunities. On the one hand, literature labels targeted advertising and marketing communication as costs that are inherent to using a service. On the other hand, personalized marketing offerings, when perceived as valuable to the consumer, are considered benefits (Martin & Murphy, 2017), indicating the delicate balancing act that results from data collection and personalization. In the scope of this research, information is considered AR-specific when it combines information collected from the various features of AR (i.e., time- and location-based services, scanning the environment or oneself, augmenting digital content into the real world) into a new source of information. For instance, choosing a particular face filter on Snapchat more often than others could be an indication of a user's beauty ideals. In turn, this information could be used to promote products or services designed to address the consumer's (implicit) needs and wants.

3 Methods

To systematically develop a valid and reliable ARIPC measure, we employed a staged process based on fundamental guidelines (Churchill, 1979) and contemporary procedures (Kiratli et al., 2016; Yim et al., 2018) for scale development.

3.1 Item Generation and Refinement

We first reviewed AR and information privacy literature, including existing privacy concern scales, to generate an initial pool of 23 items. We then presented these items to the participants in our focus group interview, who confirmed the relevance of these initial items and offered us with insights to formulate six new items. Participants also verified the need for incorporating a privacy calculus into the scale. We thus anchored the items at 1 = "benefit strongly outweighs the concern" and 7 = "concern strongly outweighs the benefit". Based on the insights gained through the focus group, a subsequent panel discussion amongst the authors expanded the item pool to 40 items. An independent AR expert from a Dutch university then reviewed these items for content and face validity, resulting in minor improvements in the wording.

3.2 *Exploratory and Confirmatory Factor Analyses*

We incorporated the 40-item scale into an online study, which was completed by 162 participants (98 women and 64 men, aged 19–65). The sample included 74 students from a Dutch university participating in exchange for course credit and 88 consumers who responded to our posting of the study on social media. Participants read an introduction to AR, then used either an AR mirror (Mister Spex) to virtually try on sunglasses or an AR retail application (Onirix) to preview home appliances. They then rated the ARIPC items, in addition to their cognitive ($\alpha = .88$) and emotional ($\alpha = .93$) engagement with the AR experience on adapted three-item scales by Hollebeek et al. (2014) as well as their AR-related WOM ($\alpha = .93$) and usage ($\alpha = .94$) intentions on adapted three-item scales by Zeithaml et al. (1996) and Hilken et al. (2020).

We conducted an EFA with principal axis factoring and direct oblimin rotation on the 40 ARIPC items. The correlation matrix revealed excessive correlation ($r = .92$) between two items, so we removed one of these items. A Kaiser-Meyer-Olkin value of .94 (Kaiser & Rice, 1974) and Bartlett's (1954) test of sphericity ($p < .001$, χ^2 (df) = 6460.01 (741)) supported the suitability of the data for factor analysis. Kaiser's (1960) criterion for retaining factors with eigenvalues greater than one suggested a five-factor solution explaining 71.9% of the total variance. However, the scree plot revealed the possibility of a three-factor solution, which, as our subsequent analyses revealed, explained a comparable amount of the total variance (65.1%) as the five-factor solution despite the lower number of items. We thus continued with the more parsimonious three-factor solution. We dropped items with low loadings (<.45) and communalities below .4 in an iterative process (Hair et al., 2010), which resulted in a final set of 10 items. A second EFA on these items revealed a three-factor solution explaining 79.03% of the total variance (Table 1). Each of the items loaded onto its intended factor, such that the final scale included four items related to *Unwanted Exposure (UnEx)*, two items measuring *Perception Bias of Reality (RB)*, and four items for *Contextualized Marketing (CM)*. The three subscales all exhibited good internal consistency ($\alpha > .7$; DeVellis, 2017).

Next, we used AMOS 26 to perform a CFA with the three previously identified factors as indicators of a higher-order ARIPC construct. We found good model fit overall (GFI = .894, AGFI = .817, CFI = .937, TLI = .912), but also a relatively high RMSEA (.113) that exceeded the threshold of 0.08 as well as a significant chi-square test ($\chi^2 = 114.976$; $p < .001$) indicating poor model fit (Hair et al., 2010). We reflect on these results in our limitations. As shown in Table 2, the composite reliability values for each construct exceeded the cut-off value of .7 (Hair et al., 2010). We also found support for convergent validity, as each item contributed ($p < .01$) to the measurement of its factor with loadings above .7. Furthermore, the R^2 values of each item exceeded the threshold of .3 and the AVE exceeded 50% for each factor (Hair et al., 2010). We also established discriminant validity, as the square root of each construct's AVE was exceeded its correlation with the other factors (Fornell & Larcker, 1981).

Table 1 ARIPC items and EFA results

Item	UnEx	RB	CM
UnEx1. It bothers me that I unintentionally give too much information about my personal economic situation, as can be derived from the quality of my AR output	**.962**	.011	.090
UnEx2. It bothers me that the combinations of my real surroundings and the virtual layers/content I choose to apply may provide interpretable information about my social status to others	**.869**	.023	.057
UnEx3. It bothers me that others might find out more about my personal preferences than I am comfortable with as a result of using AR to combine my real surroundings with digital content.	**.750**	.090	−.123
UnEx4. I am concerned that as a result of using AR, others might know more about my personal surroundings, people in my environment, or myself than I am comfortable with	**.700**	−.043	−.020
RB1. I am concerned that AR applications might bias how I evaluate the attractiveness of objects or other people, form preferences, or make decisions without me noticing, for instance, about which products or services to buy	.002	**.939**	.021
RB2. I am concerned that AR applications might bias how I see my environment or myself without me noticing	.052	**.771**	−.055
CM1. It bothers me how companies use the data that AR applications collect about the digital content that I see projected onto myself or into my environment	.060	−.140	**.901**
CM2. I am concerned that companies use the data that AR applications collect to target me with advertising related to the products I have tried out in my environment or tried on for myself by using AR	−.021	.102	**.742**
CM3. It would bother me if companies use the data collected by AR applications to provide product or service suggestions based on what I look at or what I look like	−.065	.090	**.723**
CM4. I am concerned that I do not have full control over the way companies use the data that AR applications collect about the digital content that I see projected into my environment or onto myself	.134	.003	**.722**
Eigenvalue	5.271	1.346	1.286
Percentage of variance explained	52.712	13.45	12.859
Cronbach's α	.914	.864	.867

3.3 Nomological Validity and Empirical Application

We sought to offer an empirical application and test the nomological validity of the ARIPC scale by establishing its relationship with related concepts. Specifically, we tested whether a consumer's ARIPC predict cognitive and emotional engagement with an AR experience, and, in turn, their AR-related WOM and future usage intentions. This sequence of effects is based on recent theorizing of how consumers engage with AR and adopt it as a new technology (Heller et al., 2021). Using participants'

Table 2 CFA results

Construct	1.	2.	3.	R^2	CR	AVE
1. Unwanted exposure	**.857**				.917	.734
UnEX1	.865			.748		
UnEX2	.899			.808		
UnEX3	.795			.632		
UnEX4	.865			.749		
2. Perception bias of reality	*.454*	**.844**			.831	.712
RB1		.892		.795		
RB2		.793		.628		
3. Contextualized marketing	*.604*	*.464*	**.876**		.876	.641
CM1			.837	.700		
CM2			.877	.769		
CM3			.753	.567		
CM4			.725	.526		

Notes *CR* Composite Reliability, *AVE* Average Variance Extracted. The square root of the average variance extracted is shown in boldface. Factor correlations are shown in italics

ratings of these measures from our study, we followed an approach similar to that of Yim et al. (2018) by collapsing all 10 ARIPC items into a single measure (α = .87) and then using the PROCESS macro (Model 4) to test the *ARIPC* → *cognitive /emotional engagement* → *WOM /usage intentions* mediation pathways. The results of our analyses are in Table 3. As expected, consumers' ARIPC negatively impacted their emotional and cognitive engagement with the AR experience. In turn, emotional and cognitive engagement shaped both WOM and future usage intentions. A bootstrapping procedure with 5,000 samples and bias-corrected confidence intervals (CIs) revealed significant negative indirect effects for all pathways as the CIs excluded zero (Table 3), thus supporting the overall nomological validity of the ARIPC scale.

4 Discussion and Conclusion

We address the need for a measure of consumers' AR-related privacy concerns by developing the ten-item ARIPC scale that is based on a privacy calculus for weighing the benefits and risks of using AR. Notably, this scale is comprised of three novel AR-specific privacy dimensions (Unwanted Exposure, Perception Bias of Reality, and Contextualized Marketing), while established privacy dimensions (Control, Transparency, Collection, and Perceived Surveillance) appear to not adequately describe consumers' privacy concerns towards AR. By demonstrating

Table 3 Regression results

Variables	Emotional engagement	Cognitive engagement	WOM intentions	Usage intentions
Intercept	6.15 (.31)**	4.743 (.40)**	.929 (.59)	1.295 (.68)
ARIPIC	−.474 (.07)**	−.214 (.10)*	−.056 (.10)	−.182 (.09)
Emotional engagement			.536 (.08)**	.272 (.09)**
Cognitive engagement			.300 (.06)**	.466 (.07)**
R^2 (MSE)	.205 (1.345)	.029 (2.328)	.428 (1.309)	.362 (1.766)
F	41.363**	4.846*	39.450**	29.827**
df	1, 160	1, 160	3, 158	3, 158
Indirect effects		Effect	Boot SE	Boot CI
ARIPC → emotional engagement → WOM		−.254	.061	−.37 to −.14
ARIPC → emotional engagement → Usage		−.129	.049	−.23 to −.04
ARIPC → cognitive engagement → WOM		−.064	.033	−.13 to −.00
ARIPC → cognitive engagement → Usage		−.100	.049	−.20 to −.01

Notes The numbers in parentheses are standard errors. Unstandardized coefficients are shown. Significance based on two-tailed test. ** $p < 01$. * $p < .05$

that consumers' ARIPC negatively impact their engagement and behavioural intentions, we also provide evidence for the scale's predictive power and substantiate the importance of addressing privacy concerns for mainstream adoption of AR as a new technology.

4.1 Implications for Theory

We contribute to extant AR literature in three ways. First, because of consumer backlash against early AR platforms (e.g., Google Glass), researchers have predominantly studied privacy concerns towards wearable AR devices, most notably AR smart glasses. Such privacy concerns, however, are hardware-specific and mainly relate to wearing smart glasses in public and potentially inferring with other consumers' privacy (Rauschnabel et al., 2018). In contrast, we develop a general-purpose scale that can be assessed independent of any specific AR device. Second, previous studies (e.g., Hilken et al., 2017) have largely relied on adaptations of existing privacy concern scales, such as the IUIPC (Malhotra et al., 2004), which were designed more than a decade ago in an entirely different technological and societal context.

Our findings emphasize the need for an update in the measurement of customer privacy concerns: Unwanted Exposure, Perception Bias of Reality, and Contextualized Marketing are novel and AR-specific dimensions that explain significant variance beyond well-established privacy concerns. Third, the ARIPC scale not only accounts for AR's novel technological characteristics, but also the now common practice of engaging in a privacy calculus before using a new technology. Stimulating consumers to assess their privacy concerns through a privacy calculus is an innovative approach, and, to the best of our knowledge, the ARIPC scale is one of the first attempts at implementing this calculus within a psychometric measure.

4.2 Implications for Practice

Our findings also offer a number of implications for practitioners seeking to deploy AR to enhance their interactions with consumers. First, as consumers' ARIPC negatively impact their engagement with AR, practitioners should increase their efforts to decrease privacy concerns when using AR. Second and relatedly, the ARIPC scale offers insights into what consumers are concerned about when using AR technology, which offers specific guidelines for practitioners. That is, allaying fears about unwanted social or economic exposure, a biased perception of reality, and contextualized marketing should be at the topic of managers' and developers' agendas when designing AR applications. For instance, assuring potential users of an AR application that their data will not be used for marketing purposes might be effective in reducing privacy concerns and stimulating engagement with using the app. Third, because consumers often do not automatically follow through on their intentions to use a new technology, reinforcing consumer-to-consumer WOM is particularly vital to the mainstream adoption of new technologies. The results of our nomological testing reveal that the negative effect of customers' ARIPC on WOM is mainly driven by lower emotional engagement. Practitioners should thus not only consider the design and functionality of AR applications, but also deploy AR at the right time in the consumers' purchase journey to alleviate customer pain points and associated negative emotions (Hilken et al., 2018)

4.3 Limitations and Future Research

We acknowledge some limitations that offer opportunities for further research. First, there was some ambiguity in the goodness-of-fit measures within our CFA. Although, according to Hair et al. (2010), this is not unusual as no index can differentiate good from poor models in all contexts, the validity of the ARIPC should be further evaluated. Second, while we sampled a diverse set of consumers, the majority of participants can be considered early adopters of new technologies (with an average age of 26.96). Further testing of the ARIPC, particularly in late-adopter segments would enhance the generalizability and help identify boundaries of the scale's application. Third, while behavioural intentions offer important first insights into the nomological validity of the scale, future research should investigate the effect of consumers' ARIPC on their actual behaviour (e.g., purchase choices, app usage behaviour, social media likes/posts). Fourth, while the ARIPC appears valid across two major types of AR applications (enhancing the self, enhancing the environment), an update of the scale might become necessary the technology evolves to include more social (Hilken et al., 2020), multisensory (Heller et al., 2019b), or AI-enabled features (Chylinski et al., 2020).

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