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Extending reality

Uses, processes, and persuasive effects of augmented reality apps

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General Conclusion and Discussion

MAIN CONCLUSIONS

The aim of this dissertation was to enhance our understanding of the uses, processes, and persuasive effects of AR apps. To fulfill this aim, this dissertation examined 1) the prevalence, user characteristics, and gratifications of AR apps, 2) the persuasive effects of AR apps and its underlying processes, and 3) the effects of type of AR device on user experiences. Based on the findings of this dissertation, seven main conclusions are drawn.

1. AR app users are younger, more highly educated, more tech savvy, and have lower privacy concerns compared to non-users.

This dissertation provides relevant insights on consumers' use of AR apps. Chapter 2 shows that AR app users are more likely to be younger, highly educated, and technology innovative than non-users. Additionally, AR app users have lower privacy concerns than non-users. This is also reflected in non-user's preference to use AR, since people with high privacy concerns have a lower preference to use AR (as opposed to non-AR). While current AR app users are more likely to be young, older people have a higher preference to use AR (as opposed to non-AR) among current users and non-users. This finding suggests that while AR app users now tend to be younger, older people also show interest in the use of AR apps (i.e., have preference for AR). Therefore, the use of AR apps could become more widespread in the future, as is common when a technology becomes more widely adopted (Rogers, 2003). Regarding the prevalence of AR app use, Chapter 2 shows that about a quarter of a representative sample of the Dutch population has used an AR app at least once before. This confirms that AR apps are entering the mainstream (Porter & Heppelmann, 2017).

2. Entertainment and innovation are the strongest gratifications obtained from AR app use, followed information and social empowerment.

Four gratifications are identified in relation to AR app use: hedonic (entertainment), utilitarian (information), social (social empowerment), and technology-related (innovation) gratifications. Chapter 2 has identified these four overarching gratifications for a variety of AR apps among actual AR app users. *Entertainment* (the extent to which the app is experienced as entertaining) and *innovation* (the extent to which the app is experienced as innovative/different/unusual) are the strongest gratifications obtained from AR app use, followed by *information* (the extent to which the app is experienced as informative). Entertainment is the strongest (positive) predictor of overall satisfaction with AR apps, followed by innovation and information. *Social empowerment* (the

extent to which the app enables to socially interact with others and impress others), was the weakest gratification obtained from AR app use and negatively predicted overall satisfaction with AR apps.

3. AR apps lead to more positive app and brand responses as opposed to non-AR apps.

In the context of shopping apps, this dissertation shows that AR apps lead to positive app and brand responses when compared to non-AR apps. Chapter 3 shows that enabling consumers to visualize products with AR on their own face (e.g., make-up) or in their own surroundings (e.g., furniture) leads to more positive affective and behavioral app responses as opposed to a non-AR app (e.g., showing a picture of the product). Moreover, the use of an AR shopping app enhances behavioral responses towards the brand, while effects on affective brand responses are absent. Chapter 4 further disentangles the effects of AR shopping apps that overlay virtual products on the users' face (i.e., self-augmentation), by examining which part of the effects can be attributed specifically to using AR (as opposed to non-AR), and which part to seeing one's own face (as opposed to seeing the product on a model). Thereby, it adds to the findings of Chapter 3 and shows that behavioral brand responses are induced specifically through the use of AR. Chapter 4 also shows a positive effect on affective brand responses, which is absent in Chapter 3. To explain these effects, it is important to consider the processes underlying the effects of AR apps.

4. The positive effects of AR apps are driven by several underlying processes: spatial presence, perceived personalization, hedonic, and utilitarian processes.

This dissertation shows that the positive effects of AR shopping apps are driven by several underlying processes. First of all, this dissertation focuses on underlying processes that are directly related to the technological features of AR (i.e., spatial presence and perceived personalization). Second, this dissertation focuses on hedonic and utilitarian processes, which comprise the general user experience. Together, these processes explain *why* an AR app leads to more positive app and brand responses, as opposed to a non-AR app. In the following, the underlying processes and how they affect app and brand responses are separately discussed.

A. Spatial presence and perceived personalization enhance app responses and differently affect brand responses, depending on the type of augmentation.

Spatial presence and perceived personalization are directly related to the technological features of AR apps. AR adds an extra, three-dimensional layer to

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the consumer experience that can be interacted with in real time (Azuma, 1997). As Chapter 3 shows, these unique features enable users to experience virtual objects as actual objects in one's own physical environment, thereby inducing stronger spatial presence in an AR shopping app, as opposed to a non-AR app. Moreover, by overlaying virtual products onto the real world, AR enables users to visualize products in a personally relevant context (e.g., their own face or living room). Therefore, the shopping experience is also perceived as more personalized in an AR app, than in a non-AR app. Consequently, Chapter 3 shows that spatial presence and perceived personalization lead to positive affective and behavioral app responses. Depending on the type of augmentation, spatial presence and perceived personalization also enhance behavioral brand responses. For an AR app that augments the user's face with virtual products (self-augmentation; e.g., make-up), perceived personalization enhances behavioral brand responses, while for an AR app that shows virtual products in one's surroundings (augmentation of the surroundings; e.g., furniture), spatial presence enhances behavioral brand responses. These findings suggest that personalization of the experience is a more important decision aid when judging products that are more directly related to the self (e.g., make-up, clothes, shoes), while spatial presence is a more important decision aid when judging products within one's personal environment (e.g., furniture, TV, wall paint), in which spatial attributes are more relevant. Lastly, Chapter 3 does not show an effect on affective brand responses through spatial presence and perceived personalization.

B. Both hedonic and utilitarian processes drive positive user experiences in AR.

Besides focusing on underlying processes directly related to the features of AR, processes comprising the user experience in AR are also important in driving positive effects of AR apps and devices. First of all, Chapter 2 shows that entertainment (hedonic gratification) and information (utilitarian gratification) are important gratifications obtained from using AR apps and positively affect satisfaction with AR apps across different app types. Second, Chapter 4 adds to these findings by showing that an AR shopping app is perceived as more informative (utilitarian process) and enjoyable (hedonic process) as opposed to an equivalent, non-AR shopping app. Consequently, perceived informativeness enhances behavioral brand responses, while perceived enjoyment enhances affective brand responses. Thereby, Chapter 4 also adds to the findings of Chapter 3, by showing that affective brand responses are enhanced through enjoyment, while this effect was not found through spatial presence or perceived personalization in Chapter 3. Third, Chapter 5 shows that hedonic and utilitarian processes also explain differences in user experiences between AR devices (via spatial

presence). Thus, this dissertation demonstrates that both hedonic (e.g., entertainment, enjoyment) and utilitarian processes (e.g., informativeness) are important drivers of positive user experiences in AR. However, some differences exist in the extent to which hedonic and utilitarian processes play a role in the effects of different types of apps, as will be discussed in the seventh conclusion.

5. Perceived intrusiveness and privacy concerns negatively explain the usage and effects of AR apps.

While this dissertation mainly shows positive effects of AR apps, it also shows that perceived intrusiveness and privacy concerns negatively explain the effects and usage of AR apps. Chapter 3 shows that AR shopping apps that augment the users face with virtual products, are perceived as more intrusive than non-AR shopping apps. Consequently, perceived intrusiveness negatively affects app and brand responses. Chapter 4 adds to the findings of Chapter 3, by showing that perceived intrusiveness is partly induced by seeing one's own face (as opposed to seeing a model), and by AR technology specifically (as opposed to non-AR). However, as opposed to the findings of Chapter 3, perceived intrusiveness does not negatively affect brand responses in Chapter 4. Perceived intrusiveness is likely activated in two ways. First, users need to provide camera access to enable the AR function, which can make users feel as if they are not in control over their personal information (Poushneh & Vasquez-Parraga, 2017). Second, due to the novelty of AR technology, users may feel inexperienced and unfamiliar with the technology when experiencing it for the first time (Hopp & Gangadharbatla, 2016), which may induce an unpleasant feeling and raise intrusiveness. Chapter 2 provides support for these assumptions, by showing that privacy concerned people are less likely to use AR apps in general (not specific to shopping apps). Moreover, for non-users (who are new to the technology), privacy concerns negatively affect preference for AR.

6. Wearable AR devices lead to a more positive user experience than handheld AR devices.

This dissertation reveals that wearable AR devices (e.g., AR glasses) enable a more positive user experience with AR apps than handheld AR devices (e.g., smartphones). In this dissertation, AR devices are characterized as having high or low *embodied congruence*, which is the extent to which the control and interaction with virtual objects is congruent with how one would naturally control and interact with actual, physical objects in the real world. Chapter 5 shows that wearable AR devices (characterized as high embodied congruence), are perceived as having more hedonic and utilitarian

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value than handheld AR devices (characterized as low embodied congruence) when playing an AR game. This effect is mediated by spatial presence. Moreover, playing a game on a wearable AR device leads to a higher future use intention of the device as opposed to playing the game on a handheld device. This effect is mediated through spatial presence and hedonic value, but not utilitarian value. Thus, besides AR apps (as opposed to non-AR apps), wearable AR devices (as opposed to handheld AR devices) also have an ameliorating effect on spatial presence and consequently hedonic and utilitarian processes.

7. Differentiating between app types is important in understanding the uses, processes, and persuasive effects of AR apps.

In general, this dissertation shows that it is important to differentiate between app types when examining the uses, processes, and persuasive effects of AR apps. Chapter 2 shows differences between consumer apps (shopping, entertainment, information, game, and social media AR apps) in the individual characteristics of its users, the gratifications obtained from AR apps, and preference for AR. Consumers tend to have preference for AR (as opposed to non-AR) in shopping, game, and information apps (higher than for entertainment and social media apps). Moreover, different AR apps induce different types of gratifications and processes. For shopping and information apps, information is an important gratification, while other apps (game, entertainment, and social media apps) are mainly driven by entertainment and innovation. This is also reflected in Chapter 5, in which future use intention of an AR game is enhanced through hedonic value (similar to entertainment), but not through utilitarian value (similar to information). Therefore, the user characteristics, gratifications, underlying processes, and persuasive effects that play a role differ per type of AR app.

DISCUSSION

Theoretical Implications

Through merging the real and the virtual world, AR apps provide user experiences that were previously unavailable in traditional (e.g., TV, radio, magazines) or digital media and technologies (e.g., mobile media, social media, websites). To begin with, this dissertation contributes to our theoretical understanding of *whether* and *why* AR apps differently shape the persuasion process as opposed to other digital media or technologies (e.g., mobile media, social media, websites). While the use of traditional media is characterized by passively perceiving media content, digital media enable

users to actively interact with or through media technologies, devices, and channels (Sundar & Limperos, 2013). These differences have led to new underlying processes (e.g., perceived interactivity), and gratifications (e.g., more social gratifications) which could explain how digital media technologies affect user responses (Sundar & Limperos, 2013; Voorveld et al., 2018). With the emergence of AR, allowing for new ways of interacting through media devices, this begs the question whether the use and effects of AR apps can be explained by similar processes and gratifications as other digital media technologies.

While consumers previously had to rely upon two-dimensional screens to obtain digital information, AR adds an extra, three-dimensional layer to the consumer experience that can be interacted with in real time. This dissertation shows that due to these unique features, the use of AR apps *intensifies* persuasive effects (app responses, brand responses) when compared to digital, non-AR equivalents. Nevertheless, the processes that explain *why* AR apps lead to stronger persuasive effects are similar to the processes that have been examined in relation to the effects of other digital media and technologies. Yet, this dissertation signifies that certain processes become more important in explaining these effects and at the same time may differ for different types of AR apps.

The main underlying process that directly relates to the unique features of AR is *spatial presence*. While the concept of spatial presence has also been used to explain how traditional and digital media can induce a feeling of being present in another (virtual) environment (e.g., Lee, 2004), it becomes an even more important concept in explaining the effects of immersive technologies and specifically AR. Because AR integrates virtual objects in the real world, the perception of how realistic these virtual objects are perceived in the physical space (i.e., spatial presence) is an important indicator of the quality of the AR experience and can explain the strength of the effects of AR apps. Thus, compared to previous digital media and technologies, spatial presence becomes more important in explaining the effects of AR. The role of spatial presence as a theoretical explanation of the effects AR apps has also been supported by other AR studies (e.g., Hilken et al., 2017; Verhagen et al., 2014). In addition, this dissertation also shows that spatial presence can explain differences in user experiences between wearable and handheld AR devices.

Besides spatial presence, this dissertation focuses on the role of *perceived personalization* and *perceived intrusiveness*, which have been used to explain positive and negative consequences of personalized advertising and communication (Baek & Morimoto, 2012). In digital media, personalization is mostly applied by using personal data to show relevant information or ads which are tailored to individual consumers

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(Baek & Morimoto, 2012). In relation to AR, the technology enables consumers to visualize products in a personally relevant context. This is also referred to as *context-driven personalization* (Tam & Ho, 2006). While personalized advertising pushes content, the AR app user actively chooses to personalize their experience. However, similar as for personalized advertising, perceived intrusiveness can be induced by AR apps through a lack of control over their personal information (Baek & Morimoto, 2012). To our knowledge, this dissertation is the first to apply these processes to explain the effects of AR apps, thereby also focusing on potential negative effects of AR apps. As such, it adds to the theoretical explanations of *why* AR apps are able to induce stronger persuasive effects than non-AR apps.

Additionally, this dissertation focused on the underlying processes and gratifications related to the user experience. This dissertation identifies four main overarching gratifications obtained from AR app use: entertainment, information, innovation, and social empowerment. Thus, it shows that the use of AR apps can be explained by similar gratifications as other digital media (e.g., social media; Voorveld et al., 2018) and does not necessarily lead to new gratifications. Moreover, other AR studies have examined similar hedonic (e.g., entertainment, enjoyment), utilitarian (e.g., usefulness, informativeness), and innovation-related (e.g., perceived novelty) constructs or processes to explain effects of AR shopping apps (e.g., Hilken et al., 2017; Yim et al., 2017). This dissertation confirms that these constructs are important factors enhancing the user experiences of a variety AR apps. However, social gratifications have not received much attention in AR research. The negative effect of social empowerment on satisfaction may suggest that current social AR functions (e.g., sharing AR-enriched content) do not provide added value to consumers, as was also shown by the lower preference for AR in social media apps compared to other AR apps.

Based on the above, this dissertation concludes that AR *enriches* existing media (mobile apps, website applications, games, social media) through its unique features and thereby can *intensify* media effects, which are mostly positive, but can be negative in some cases. The idea that AR can enrich existing media or experiences is also supported in AR research in other domains. For example, in an educational setting AR can enrich learning and training experiences because the three-dimensional visualization of concepts enhances learning and performance (Dey et al., 2018). Research has also shown that maintenance and manufacturing processes can be made more efficient through the use of AR glasses, as opposed to, for example, using a textual manual (see Dey et al., 2018, for an overview). This dissertation adds to previous research by showing that AR can also enrich consumer experiences by enabling users to visualize products, information, and other content that previously was enabled through two-dimensional screens.

Besides contributing to our theoretical understanding of how AR apps differ from other digital media, this dissertation also contributes to our understanding of the factors that enhance or limit the use of AR apps. In doing so, this dissertation provides a state of the art on adoption of AR apps. Since previous AR studies have mostly focused on non-representative samples, one app type and/or forced exposure to AR apps, insights on consumers' use of AR apps was very fragmented. This dissertation shows that the user characteristics of AR app users are in accordance with *diffusion of innovations theory* (Rogers, 2003), which states that younger, highly educated, tech savvy people tend to adopt technologies quicker, especially in the first phase of introducing a new technology (Rice & Pearce, 2015; Venkatesh et al., 2003). While previous AR studies have shown that privacy concerns could diminish the effects of AR apps (Feng & Xie, 2019; Hilken et al., 2017), this dissertation adds to these findings by showing that people with high privacy concerns are also less likely to use AR apps. In addition, this dissertation provides a more differentiated understanding of consumer's use of AR apps, by showing relevant differences between app types in terms of user characteristics, gratifications, and preference for AR. In doing so, this dissertation provides a broader view on the current mobile AR user landscape, which can guide future research.

Finally, this dissertation highlighted the importance of embodied congruence as a key predictor of meaningful AR user experiences. More specifically, Chapter 5 proposes embodied congruence as a theoretical conceptualization of how wearable AR devices can enhance the user experience compared to handheld AR devices. Thus, besides showing that AR apps lead to stronger persuasive effects than non-AR apps, wearable AR devices enable even stronger user experiences than handheld AR devices. Thereby, this dissertation does not only focus on the differences between AR and non-AR, but moves a step further in improving our theoretical understanding of how experiences *within* AR can be improved. These findings do not only advance AR literature, but also natural mapping and embodied cognition frameworks, by integrating elements from both theories in the conceptualization of embodied congruence. This conceptualization can be extended to different types of embodied interactions within and beyond AR (e.g., Virtual Reality, gaming) and may be generalizable to other contexts outside the AR game context used in this dissertation.

Limitations and Suggestions for Future Research

Altogether, this dissertation considered the use, processes, and effects of AR apps by distinguishing different app types (e.g., shopping apps, game apps), AR devices (handheld vs. wearable AR devices), and types of augmentation (self vs. surroundings).

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Figure 6.1 Visualization of the Relations Examined in this Dissertation
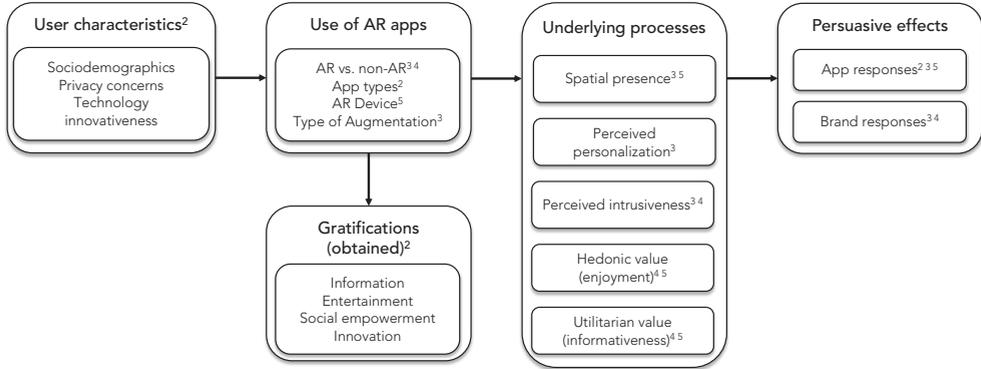
Note. [2] Chapter 2, [3] Chapter 3, [4] Chapter 4, [5] Chapter 5

This dissertation explored the individual characteristics that predict the use of AR apps and subsequently, the gratifications, underlying processes, and persuasive effects of AR app use. These relations are visualized in Figure 6.1. While this dissertation provided relevant theoretical implications based on these relations, future research can add and extend the findings of this dissertation by examining the relations that remain unexplored, and by addressing the limitations of this dissertation in exploring these relations.

Three main directions for future research emerge from the relations in Figure 6.1 that remain unexplored. First, this dissertation focused on the effects and underlying processes of AR apps (versus non-AR apps) and AR devices in one specific context (respectively a shopping and game context). This begs the question whether the same effects and underlying processes play a role when considering other AR app types as were examined in Chapter 2 (e.g., social media and information apps). As shown in Chapter 2, the use of AR in social media apps is relatively high, and preference for AR in information apps is relatively strong. Therefore, future studies should also experimentally examine whether the processes and effects found in this dissertation are generalizable over other app types. Since Chapter 2 also shows that gratifications obtained from AR app use differed between app types, there may be different processes that play a role for social and informative AR apps. For example, utilitarian value may be more important in explaining effects of informative apps, while hedonic value or social processes may be more important in explaining effects of social media

apps. Since the use of AR in social media apps was high, but preference relatively low, future research should also examine how social media can (more) effectively incorporate AR experiences in their apps. In addition to app type, the role of AR device and type of augmentation may also influence these effects, and should be taken into account when examining the effects of AR apps.

Second, this dissertation has shown which user characteristics predict AR app use across different app types on mobile devices. However, user characteristics could also affect the relation between the use of AR, its underlying processes, and its persuasive effects. While Chapter 2 focused on a large representative study sample, the experiments in Chapter 3, 4, and 5 focused on relatively young and tech savvy study samples. The findings in Chapter 2 showed that AR app users are more likely to be young, highly educated, innovative, and less privacy concerned, which validates the choice for using a young, tech savvy study sample as the main target group of AR apps. However, adoption of AR apps is likely to become more widespread in the future, which also questions whether the effects found in this dissertation can be extended to other study samples. For example, older age groups tend to be less tech savvy (Rogers, 2003) and therefore may respond less favorably to AR apps. At the same time, wearable AR devices might be especially favored by older users (compared to handheld AR devices) as it would allow them to behave more naturalistically without having to learn new features of the platform. Therefore, future research should not only consider broader study samples, but it also could examine the influence of personal characteristics such as age on the effectiveness of AR apps and devices.

Third, this dissertation showed that AR apps may have negative effects due to the perceived intrusiveness of AR apps and privacy concerns in relation to AR apps, but findings were inconclusive and do not present a full picture of the relation between these concepts. Based on the findings across this dissertation, it is likely that there is an interplay between a person's privacy concerns (which limited usage of AR apps in Chapter 2), the extent to which consumers find AR apps intrusive (which negatively affected consumer responses in Chapter 3), and their willingness to share personal data to enable the use of AR apps (Chapter 4). More research is needed that focuses on how the interplay between these factors can negatively affect the usage and effects of (different types of) AR apps, and how these could be limited (e.g., providing consumer's control over their personal data). While these findings were specific to AR mobile apps, privacy concerns and perceived intrusiveness may be even stronger (negative) predictors of the adoption and effects of wearable devices, since these are able to collect more sensitive information and are relatively new to consumers (Liao, 2018). Moreover, the experiments in this dissertation focused on young, tech savvy

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samples, which tend to be less privacy concerned in general (Wottrich et al., 2018) and suggests that negative effects of AR apps could be stronger when considering more diverse study samples. Therefore, future research should examine potential factors negatively affecting the effects of AR apps and devices, while considering representative study samples.

Besides extending the findings of this dissertation to other app types, devices, and populations, this dissertation presents some limitations that need to be addressed in future research. The studies in this dissertation were either performed in an experimental setting, or focused on cross-sectional data and self-reported measures. This provides some limitations with regard to the ecological validity of the findings. While an experimental lab setting was appropriate to draw causal relations between the use of AR apps (as opposed to non-AR apps) and AR devices (wearable versus handheld) and how these affected consumer responses, findings could be different when considering more natural settings and measures. For example, one of the benefits of AR apps is that they enable users to place virtual objects in a personally relevant context (e.g., place a virtual couch in their own living room). However, this natural setting was not available for studies performed in a lab setting (Chapter 3 and 5). Therefore, the effects of AR apps and devices may be stronger when considering more natural settings. Moreover, the findings of this dissertation relied on self-reported measures and used cross-sectional data. As such, actual AR app use may be higher than reported in Chapter 2. To increase the ecological validity of the findings, future research can employ field experiments to examine whether effects are similar when considering more natural settings. Additionally, future research should employ longitudinal study designs to identify important trends in AR app use over time. Moreover, a combination of behavioral metrics in relation to AR app use (e.g., interaction time, frequency of AR app use, in-app behavior) and attitudinal measures as used in this dissertation can help to get a better understanding on the usage and effects of AR apps.

Lastly, since AR is a relatively new technology, a large part of the participants in the experiments were likely new to using AR apps. Therefore, the effects found across the experiments may partly be attributable to a novelty effect. On the one hand, the increased novelty of using AR (as opposed to non-AR) may have induced stronger positive effects, as has been shown in previous AR research (Yim et al., 2017). On the other hand, the negative effects of AR apps (through perceived intrusiveness) may also be partly attributable to a novelty effect (as discussed in Chapter 3). Therefore, over time, when this novelty effect wears off, the effects of AR apps (as opposed to non-AR) may become less strong. Chapter 5 party accounted for the novelty effect of using wearable AR devices (as opposed to handheld devices) and showed that it could

not explain the stronger effects of wearable AR devices. Nevertheless, future studies should take into account and control for the role of the novelty effect when examining the effects of AR apps and devices.

Practical Implications

Due to the novelty and rising popularity of AR in the consumer market, insights from this dissertation are highly relevant in practice. Knowledge on the uses, processes, and persuasive effects of AR apps is essential to effectively and responsibly develop AR solutions that add value to consumer's everyday life, while also protecting consumers from unwanted outcomes. Based on the findings in this dissertation, practical implications are formulated for marketers, app developers, and policy makers.

Implications for Marketers and App Developers

While marketers and app developers have started experimenting with AR, a lack of understanding and knowledge about the technology, its users, and a clear vision on the added value of AR has been a barrier to move past an experimental phase (BCG, 2018). Based on the findings in this dissertation, several insights are provided that can help to effectively develop and incorporate AR apps that provide value to consumers. Based on the prevalence and frequency of AR app use, social media apps and game apps provide interesting opportunities to incorporate (branded) AR experiences within existing AR apps, since these already provide a large audience. On the other hand, preference for AR in current users and non-users was relatively high in shopping and information apps. Thus, based on the product or service offered, enabling consumers to use AR apps to visualize products or services, or to provide textual/visual information can be interesting commercial opportunities that provide value to consumers.

Additionally, this dissertation gave specific insights into the persuasive effects of AR shopping apps. This dissertation showed that AR apps enable marketers to personalize shopping experiences and provide a more realistic view of products compared to previously available online product presentations (e.g., pictures of a product), which can enhance purchase intentions when shopping online. Therefore, AR shopping apps show potential to reduce issues currently faced by marketers and retailers with regard to online shopping, such as high return rates, *online shopping card abandonment* (dropping out of the process before completing the purchase), and *webrooming* (browse products online, then shop product offline; Dacko, 2016; Hilken et al., 2018).

At the same time, the studies in this dissertation also showed that AR apps were perceived as more intrusive than non-AR apps, which may lead to negative persuasive effects in some cases (as shown in Chapter 3). Even more so, privacy-concerned

consumers are less likely to use AR apps and have lower preference for AR. Therefore, it is advisable to give consumers information on how their personal data are being used and give them control over which personal data they want to share. Moreover, to limit potential negative effects of AR apps it is advisable to give consumers the option to choose for the AR function, while also providing an alternative, non-AR function.

Although AR is now mostly adopted through smartphones, wearable AR devices (e.g., AR glasses) are promising as a future consumer device. This dissertation showed that wearable AR devices provide a more enjoyable and useful user experience than handheld devices, by enabling users to more naturally interact with virtual objects in the physical world. While wearable AR devices are now mostly used as enterprise solutions, more lightweight, affordable wearable AR glasses are being developed by big tech companies that will enter the consumer market in the next years (Porter & Heppelmann, 2017). As such, marketers may want to invest in a future in which digital information is increasingly transmitted and exchanged through wearable devices, especially for brands or companies wanting to be at the forefront of digital marketing innovations.

Lastly, the insights in this dissertation provide guidelines on developing successful AR apps that provide value to consumers. To induce an enjoyable, as well as functional AR experience, the integration of virtual objects within the real world should be as lifelike as possible (i.e., spatial presence). In addition, allowing users to interact with virtual objects congruent with how one would naturalistically perceive and interact with physical objects (i.e., embodied congruence) can furthermore induce better and more realistic AR user experiences.

Implications for Policy Makers

Knowledge on how AR affects the persuasion process can inform policy makers whether actions need to be taken to prevent unwanted outcomes. This dissertation raises several issues in relation to the collection of personal data through AR apps and devices. As this dissertation showed, AR increased the perceived intrusiveness of mobile apps, and privacy concerned people may be less inclined to use AR apps. At the same time, the results in Chapter 4 showed that consumers were even more willing to share their personal data to use AR apps, despite the higher perceived intrusiveness of AR apps. Previous research in relation to mobile apps has already shown that users make a cost-benefit analysis, in which users are willing to share their personal data with apps (costs) as long as it provides relevance (benefits) to its users (Wottrich et al., 2018). This may be more worrisome in relation to AR apps, as more sensitive personal data is being collected through the employment of AR. Since AR apps aim to realistically

integrate virtual objects in the users' physical surroundings, it continuously scans the user's surroundings. In doing so, AR apps are able to collect sensitive information about the user's environment, their location, and their behavior (Liao, 2018).

In addition, since this dissertation showed that AR app use is becoming more mainstream, this means the physical world is increasingly being superimposed with virtual objects, the so-called "virtual augmented space". This begs the question whether both users of AR apps and companies are allowed to place virtual objects anywhere in the public space. For example, are advertisers allowed to overlay virtual advertising at any physical location in the public space? This also pertains to the fear of overloading consumers with virtual information and specifically advertising (Liao, 2018).

To address these issues, regulations need to be implemented that prevent unwanted outcomes and protect consumers. Policy makers should therefore regulate privacy and content issues in relation to AR and determine what type of content (e.g., advertising) and features (e.g., face recognition) are allowed the be employed via AR devices, to warrant a future in which the positive potential of AR can be employed, while also protecting consumers from unwanted outcomes (e.g., collecting too much sensitive information).

OVERALL CONCLUSION

In sum, the findings of this dissertation revealed whether, when and why AR apps are able to enhance persuasion as opposed to equivalent, non-AR experiences and by comparing different AR devices. As such, it illustrates through which processes (spatial presence, perceived personalization, hedonic and utilitarian processes) different AR apps and devices enhance app and brand responses. Moreover, this dissertation shows which factors drive the usage of AR apps, both in terms of the user characteristics predicting AR app use, as well as the gratifications and underlying processes that can drive future use of AR apps and devices. This dissertation also shows factors negatively affecting adoption and persuasion of AR apps (e.g., privacy concerns, perceived intrusiveness). Lastly, the prevalence of AR app use (about a quarter among a representative sample) signals that AR apps are entering the mainstream and validates future research in this area. Altogether, the findings of this dissertation provide a comprehensive overview of the uses, processes, and persuasive effects of different types of AR apps and devices, and contribute to our understanding of the AR app user landscape.

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