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ARTICLES

Augmenting Reality: An Exploration of the Intention to Use Commercial Augmented Reality Comparing Older and Younger Adults Differing in Technology Innovativeness

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ABSTRACT. The interactive technology augmented reality (AR) layers virtual elements upon the real world of its users, and it is becoming increasingly popular in various fields. Previous research has shown that it can be a valuable tool in the decision-making process of consumers since it enables them to virtually try-out products. However, these studies focused primarily on general persuasive effects, and young, tech-savvy samples. Therefore, the study by Riethorst et al. focuses on the influence of both age and technology innovativeness on the intention to adopt commercial AR, using the Technology Acceptance Model as a theoretical base. Based on a field experiment (N = 71) at the home addresses of the participants, this study shows that younger and older adults do not differ in their intention to use commercial AR. However, when taking the level of technology innovativeness into account, the results show that for older adults, ease of use and consequently usefulness, enjoyment and use intention, increase (decrease) as the level of technology innovativeness increases (decreases). For younger adults, the level of technology innovativeness did not matter. These results can elevate the knowledge of marketers who are considering implementing commercial AR and furthermore help them to pinpoint their specific target groups.

KEYWORDS. Pull marketing, digital marketing, Internet, customer journey, European marketing, HP, user-generated content

INTRODUCTION

Today's marketers seek new and innovative ways to promote brands, products and services among their target groups. Consumers are often overloaded with advertisements and they view themselves increasingly as active and self-determining individuals who want to experience how these brands, products and services are subsidiary for them personally (Customertalk, 2017; Hyland, 2019; Smilansky, 2009). A tool that has the potential to stimulate the

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consumer experience in a creative and interactive manner, and which has been receiving a growing interest from marketers all over the world, is AR (Intemarketing, n.d.; Ketelaar, 2018).

Augmented reality (AR) is an interactive technology that adds a virtual layer to the physical environment of consumers. It can be experienced through various devices, including smartphones, tablets and special wearables (Javornik, 2016a; Yim, Chu & Sauer, 2017). The added layer enables consumers to envision 3D products in their direct environment or on themselves and to therefore 'try-out' these products virtually as if they were real (Huang & Liao, 2015; Javornik, 2016a; Smink, Frowijn, van Reijmersdal, van Noort & Neijens, 2019). For instance, cosmetic brand Sephora developed an AR app in which consumers can virtually try out make-up products on themselves (Paine, 2018). Hence, AR aims to minimize the feeling of risk when shopping online; it can help with consumers' decision-making process (Huang & Liao, 2015) and therefore is able to create a bridge between physical and online shopping.

Recently, AR has attracted more and more attention from marketers. For example, market research office IDC expects investments in AR in the retail sector to rise by up to 2.7 billion euros by 2021 (Armstrong, 2018; Gijsbrechts, 2017). Several big players in retail (e.g. IKEA, Sephora, Converse) have already integrated AR technology into their marketing mix (Paine, 2018; Quoc, 2018) and this may be beneficial for many other brands because of its broad application possibilities (Gervautz & Schmalstieg, 2012). Moreover, both Google and Apple are anticipating by developing assistive technologies to optimize the digital AR experience for their users (Zandjans, 2017), which has led to an increase in the amount of AR apps available for consumers.

Despite this growing attention and recent developments, many marketers still seem reluctant to implement AR into their marketing mix, because investing in the right AR content may be considered relatively risky and expensive (BCG, 2018; Vermeulen, 2016). BCG (2018) reports that these concerns appear to be rooted in a lack of knowledge or understanding. Simultaneously, scientific research on commercial AR is still in its infancy. Academics have started examining, for example, the impact of AR on consumer experiences (e.g. Flavián, Ibánes-Sánchez & Orús, 2019; Poushneh & Vasquez-Parraga, 2017; Scholz & Smith, 2016), underlying mechanisms (e.g. Huang & Liu, 2014; Yim et al., 2017) and brand responses (e.g. Rauschnabel, Felix & Hinsch, 2019; Smink et al., 2019). But, in order to predict the acceptance and adoption of commercial AR, some academics have also examined the technology with the help of the well-known Technology Acceptance Model (e.g. Huang & Liao, 2015; Kim & Forsythe, 2008). However, not much is known about the role of individual characteristics in this acceptance process. In order for marketers to understand how AR has added value to their brands, it is important to provide them with knowledge about which type of consumers are targetable with AR. The current paper tries to add to this knowledge by building on the AR adoption studies of, for example, Kim and Forsythe (2008) and extending it in three ways.

First of all, the majority of AR studies focus mainly on young, tech-savvy consumers, and therefore an important characteristic seems to be neglected in these studies: age. Older adults might respond differently to AR than younger adults, as they seem generally less technology skilled (CBS, 2018; Morris & Venkatesh, 2000; Van Deursen & Van Dijk, 2012) and slower in adopting new technologies (e.g. Hanson, 2010; Rice & Pearce, 2015). However, older adults are a fast-growing proportion of both internet users (CBS, 2018; Hunsaker & Hargittai, 2018) and online consumers (CBS, 2018; Lian & Yen, 2014), and consequently they are more and more considered to represent a target group for marketers and online retailers

(Wade, 2017; Tama-Rutligliano, 2017). Exploring the potential use of commercial AR by older adults, in contrast to younger adults, is valuable for marketers and brands that deal with several generations as target groups and are considering the implementation of commercial AR.

Second, an individual's disposition toward trying new technologies, technology innovativeness, may also be an important individual characteristic that influences the adoption of AR and it may interact with age (Kim & Forsythe, 2008; Robinson, Marshall & Stamps, 2005). Having greater levels of technology innovativeness may signify, for example, heightened ability to interpret new innovative stimuli (Kelly, 1955; Payne & Beatty, 1982) and more confidence in one's own capabilities of using new technologies (Lu, 2014). This suggests that using AR may require less effort from those with high technology innovativeness levels, which is a substantial element of the Technology Acceptance Model (TAM), which serves as a theoretical base in the current paper. Moreover, technology innovativeness is an individual characteristic and some studies show that this can vary within age groups (Lu, 2014; Rogers, 2003). This suggests that technology innovativeness might interact with age in affecting the intended adoption of AR.

Third, while in most AR research the phenomenon has been examined using a survey or lab experiment, the current study applies a field experimental design (i.e. in the participants' homes). Actual use of commercial AR generally takes place in the consumer's own environment, thus testing AR in a more natural setting benefits the external validity of the results.

In sum, this study aims to contribute to the scientific state of the art regarding commercial AR, by taking into account individual characteristics (age and technology innovativeness) that may influence the adoption of AR and by applying a field experimental design. As such, the current study can provide brands and marketers with knowledge about the application of commercial AR among individuals with various age and technology innovativeness levels.

THEORETICAL BACKGROUND

Augmented Reality within the Marketing Landscape

Originally, Azuma (1997) described the unique features of AR technology as threefold: 1) it combines the real with the virtual world; 2) it is interactive and in real time; and 3) it is registered in 3D. The technology superimposes virtual elements upon the environment of the user (Smink et al., 2019). It therefore does not fully replace its physical environment like virtual reality (VR) does, but rather enriches the sensorial perception of users' physical environment by adding virtual elements (Daponte, De Vito, Picariello & Riccio, 2014; Milgram, Takemara, Utsumi & Kishino, 1994).

Together, marketing, advertising and sales seem to represent one of the most promising application fields for AR (Gervautz & Schmalstieg, 2012). GCB (2018) reports that it has the potential to transform the way we market, especially considering that it enables several types of marketing opportunities, ranging from brand play and activation, foot traffic and wayfinding, to product try-on and showrooming. The current paper focuses on the latter[1]

This form of AR enables consumers to virtually try out and interact with products in a vivid manner (Hilken, De Ruyter, Chylinski, Mahr & Keeling, 2017; Scholz & Smith, 2016; Yim et al., 2017). It often provides them with the option to alter products to their own liking (e.g. colors, size and materials), thereby offering tailored product information (Huang & Liao, 2015). By realistically displaying virtual products in the consumers' own environment,

1 Current paper specifically focuses on commercial try-out AR but it uses the term 'commercial AR' in an effort to keep the paper legible.

it enables visual examination without requiring visual imagination like 2D product images do (Javornik, 2016a). It may ultimately contribute to improved decision making (Huang & Liao, 2015; Hilken et al., 2017; Modak & Sinha, 2019).

Technology Acceptance Model as a Theoretical Base

To examine the adoption intention of commercial AR among younger and older adults with different levels of technology innovativeness, we use the TAM (Davis, 1989) as a theoretical base. The TAM has been used to explain the use of many new technologies, including AR (e.g. Huang & Liao, 2015; Kim & Forsythe, 2008; Rese, Baier, Geyer-Schulz & Schreiber, 2017; Spreer & Kallweit, 2014), and it enjoys wide support in the information system literature as a 'powerful and robust' predictive model (Fagan, 2012; King & He, 2006). The approach or variables within the model may vary between different technologies (e.g. AR differs fundamentally from, for example, more traditional computers) or even between specific contexts. Some studies have shown the general applicability of the model in a commercial AR context (e.g. Huang & Liao, 2015; Kim & Forsythe, 2008; Rese et al., 2017; Spreer & Kallweit, 2014). Kim and Forsythe (2008) were some of the first researchers to examine virtual try-on technology (early-stage AR) and they demonstrated it to be an appropriate model to assess the use of this kind of technology. Spreer and Kallweit (2014) also present TAM to be a highly significant model with strong explanation power in the context of the intended adoption of AR in retail.

In the original TAM, Davis (1989) specified perceived ease of use and perceived usefulness of the technology as predictors of the attitude and intention to use it, which in turn predicts the actual use of the technology. Ease of use reflects the degree to which a person believes the specific technology is free of effort, while usefulness reflects the degree to which a person believes that usage of the specific technology enhances their performance or functioning (Davis, 1989; Marangunić & Granić, 2015). In several contexts, including the AR context, it is not necessary to include the attitude toward the technology as a mediator (Davis et al., 1989; Huang & Liao, 2015; Legris, Ingham & Collerette, 2003; Marangunić & Granić, 2015; Spreer & Kallweit, 2014), essentially because an individual is able to form a strong behavioral intention without forming any prominent attitudes (Davis et al., 1989; Venkatesh, 1999).

Several authors have also emphasized adding perceived enjoyment to the model (Ha & Stoel, 2009; Huang & Liao, 2015; Javornik, Rogers, Mountinho & Freeman, 2016; Kim & Forsythe, 2008; Rese et al., 2017). Enjoyment refers to the degree to which a person experiences the specific technology as pleasant (Davis et al., 1989, p. 113). The original model of Davis (1989) described a rather utilitarian or functional side of motivation to use technology. But in the modern context of AR, a more hedonic or affective input in the form of enjoyment is important, especially since the interactive feature of AR has been shown to contain a 'fun-factor' (Kim & Forsythe, 2008; Rese et al., 2017). Furthermore, research (Gross, 2015; Ha & Stoel, 2009) highlights the importance of online shopping technologies being enjoyable for users in order for them to engage in shopping and be intent on using these technologies to do so.

Researchers who previously used an adapted TAM with the inclusion of both utilitarian and hedonic factors in an AR context demonstrated a good fit. One such study is that previously mentioned by Kim and Forsythe (2008). Huang and Liao (2015) also included a hedonic factor similar to enjoyment (playfulness) into their TAM model and compared it to a form of escapism from reality. They indicated it to be one of the key factors that fosters consumers' intention toward using AR technology. In this study, we will consider the role of TAM

in relation to differences between younger and older adults.

Age Differences in Ease of Use

Younger and older adults might differ in their evaluations of how easy AR applications are to use. The degree to which people find a new technology easy to use is an important factor in predicting the use of that technology (Davis, Bagozzi & Warschaw, 1992). This implies that users should not exhaust too many cognitive resources on using the technology. When a new technology requires too much cognitive effort from the user, and it is perceived as complex, it will be at the expense of a useful and pleasant experience (Davis et al., 1992; Venkatesh, 2000).

To our knowledge, only two studies have explored the relationship between age and ease of use within an AR context, and these provided somewhat contradicting findings. Alelis, Bobrowicz and Ang (2015) compared older and younger adults' interactions with 3D cultural artifacts on personal devices. These authors found no differences between these groups in their engagement and emotional responses to AR. This study, however, served quite a different purpose (optimizing museum experiences) and it did not focus on the role of age in the adoption intention of AR technology. In contrast, Modak and Sinha (2019) showed that there was a difference between younger and older adults in their ease of using AR technology. However, their sample of older adults was relatively small and young; only 8% of the 100 participants were 45 years or older.

There are several reasons to assume that older adults might experience more cognitive troubles while using commercial AR as opposed to younger adults, translating into a lower ease of use. First, older adults generally have less experience with the use of new computer technologies (Broady, Chan & Caputi, 2010; Dickinson, Arnott & Prior, 2007; Jacko et al., 2004; Olson, O'Brien, Rogers & Charness, 2011) and experience is a predominantly significant predictor of performance (Agarwal & Prasad, 1999; Laberge & Scialfa, 2005). Although an increasing number of older adults have access to the internet (CBS, 2018; Deursen & Van Dijk, 2011), unlike younger adults they did not grow up with internet technologies and smartphones. Perhaps as a result, relevant skills and knowledge for handling new technologies like AR seem overall less well developed (CBS, 2018; Morris & Venkatesh, 2000; Olson et al., 2011; Van Deursen & Van Dijk, 2012). Complementary to this, younger adults have been shown to approach new technologies with more intuition, efficacy and ease (Lewis, Langdon & Clarkson, 2008; Mihajlov, Law & Springett, 2014).

Second, aging is associated with lower levels of cognitive performance (Hawthorn, 2000; Salthouse, 2009). This could affect the experience of using a new technology like AR. Older adults generally encounter more difficulties with forming new memory connections, attention span, spatial abilities and coordination (Burke & Mackay, 1997; Hawthorn, 2000; Wagner, Hassanein & Head, 2010). Understanding the basics of AR and figuring out how to work with it (e.g. the interface and 'scanning' faces, objects and surroundings in order to make virtual objects appear accordingly) require a certain amount of cognitive activity. Because it is expected that older adults will experience more cognitive barriers than younger adults (Charness & Boot, 2009), this might be harder for them.

Although the reasoning above is mostly drawn from scientific papers regarding other (internet) technologies, such as the internet and mobile phones, we believe that the same can be argued in the case of commercial AR. Therefore, we expect that older adults will experience less ease of use than younger adults. This leads to the first hypothesis:

> H1: *Older adults experience less ease of use when using commercial AR than younger adults.*

The Mediating Role of Usefulness and Enjoyment

Following the guiding studies for current research (Davis, 1989; Davis et al., 1992; Kim & Forsythe, 2008) we propose that usefulness and enjoyment act as mediators between ease of use and the intention to use commercial AR. The inclusion of both a utilitarian (usefulness) and hedonic (enjoyment) dimension in the present TAM was highlighted previously. Although several studies have reported on these relationships, a clear reasoning is missing. Our argumentation for these two mediators shows somewhat common ground.

The basic principle is, as mentioned before, that the easier a technology such as commercial AR is to use, the less (cognitive) effort it requires to carry out tasks (Davis et al., 1992; Venkatesh, 2000). A task in this particular situation could be everything in the process of using AR, for instance scanning surroundings or faces, selecting desired products or visualizing them. Research has shown that effort is a finite source, so the less effort that goes toward using or performing a task, the more effort can be allocated to other tasks (Davis et al., 1992). The result could be a more efficient and aimed use of AR and the feeling of it enhancing a person's overall performance or functioning, i.e. usefulness (Davis, 1989; Marangunić & Granić, 2015).

Similarly, when less effort is required, the smoother the AR experience may feel, creating a more pleasant experience. Having to put in too much effort in this specific case could provoke irritation for a consumer since it stands in the way of their goal of using an AR app, for example shopping (Hasan, 2016). Furthermore, Davis et al. (1992) suggested that ease of use is a source of information relevant to feelings of self-efficacy, competence and self-determination, which are theorized to influence intrinsic motivations such as enjoyment.

We predict that when commercial AR is perceived as easier to use, users are more likely to perceive the technology as more useful and enjoyable, which consequently heightens the intention to use the technology. With the earlier mentioned expectation that older users will be more likely to perceive commercial AR as less easy to use than younger adults, the second hypothesis is as follows:

> H2: *Older adults will have a lower intention to use commercial AR than younger adults; this effect is mediated by ease of use and consequently usefulness and enjoyment.*

The moderating Effect of Technology Innovativeness

The degree to which commercial AR is easy to use may be influenced by individual characteristics other than age, particularly technology innovativeness. Technology innovativeness (i.e., cognitive or personal innovativeness regarding technology) can be defined as an individual's disposition toward trying any new information technology (Agarwal & Prasad, 1998; Liu, Li & Carlsson, 2010) and it is derived from Rogers' (1962) innovation diffusion theory. Spreer and Kallweit (2014) have already suggested that the factor may have a moderating effect in the TAM regarding commercial AR. There are multiple reasons to expect that consumers scoring high on technology innovativeness will experience the use of AR with more ease.

First of all, existing studies imply that individuals scoring higher on technology innovativeness are more confident in their own capabilities of using new technologies (Lu, 2014; Lu, Yao & Yu, 2005) and processing innovative information (Celuch & Evans, 1987) than individuals scoring lower on technology innovativeness. Individuals with a high technology innovativeness encounter new technologies more open-mindedly, are greater risk-takers when it comes to new technologies, and are more willing to accept it failing (Agarwal & Prasad, 1998; Batra & Vohra, 2016; Fagan, Kilmon & Pandey, 2012; Lu, 2014). This may

enable them to manage the higher levels of uncertainty involved when using new technologies with more ease. Similar to Agarwal and Karahanna (2000), we assume that this evokes a sense of being in charge and mastery over the technology interaction, which should reduce the perceived difficulty.

The second reasoning is based on the more traditional literature of both Goldsmith and Nugent (1984) and Payne and Beatty (1982), who propose that innovators are generally more cognitively complex than later adopters of innovations, which may reveal individual differences in information-processing abilities. This allows them, amongst other things, to view innovations as simpler to handle because of their heightened ability to structure and evaluate their environment (Kelly, 1955; Payne & Beatty, 1982). It helps them to interpret (structure and evaluate) better when coming into contact with a new technology such as AR, resulting in less cognitive effort.

Furthermore, Agarwal and Karahanna (2000) argue that more technology innovative individuals are likely to be more predisposed to experience episodes of cognitive absorption while using an information technology. Essentially, focused absorption suggests that all of the attentional resources of an individual are focused on the particular task, causing more cognitive resources to be allocated and reducing cognitive burden, which results in an amplification of perceived ease of use (Agarwal & Karahanna, 2000; Evaristo & Karahanna, 1998). We expect this to work in a similar way for AR, especially given the absorptive and immersive character of AR's virtuality (e.g. Javornik, 2016b; Yim et al., 2017).

Lastly, Sundar and Marathe (2010) provide a characterization of power users of technologies, which is strongly related to having a high level of technology innovativeness. These so-called power users are described as 'technophiles' who think of technology as intuitive and require less elaborate technical or navigational support when using newer technologies (Chen, Fan & Macredie, 2006; Sundar & Marathe, 2010). This suggests that there is a high possibility that individuals scoring high on technology innovativeness experience less difficulty with using a technology such as AR.

As mentioned before, younger adults are generally known to have more technological skills (CBS, 2018; Morris & Venkatesh, 2000; Van Deursen & Van Dijk, 2012) and they seem to be earlier in adopting new technologies (e.g. Hanson, 2010; Rice & Pearce, 2015). However, innovativeness is an individual characteristic, meaning that it can also differ within groups (Lu, 2014; Rogers, 2003). As such, the level of innovativeness can also vary within younger and older adults. Thus, while we propose that older adults will have a lower intention to use AR as opposed to younger adults, we expect that innovativeness will act as a moderator. As we argue that innovativeness has a positive effect on ease of use, we expect that for both younger and older adults, higher levels of technology innovativeness lead to a higher ease of use as opposed to lower levels of technology innovativeness, and as such will strengthen the effects on usefulness, enjoyment and lastly intention to use AR. Therefore, the last hypothesis is formulated as follows:

> H3: *The mediation effect of age on intention to use the AR app, via ease of use, usefulness and enjoyment, is moderated by technology innovativeness; the mediation effects are stronger for people with relatively high levels of technology innovativeness, as opposed to people with relatively low levels of technology innovativeness.*

METHODS

Design and Participants

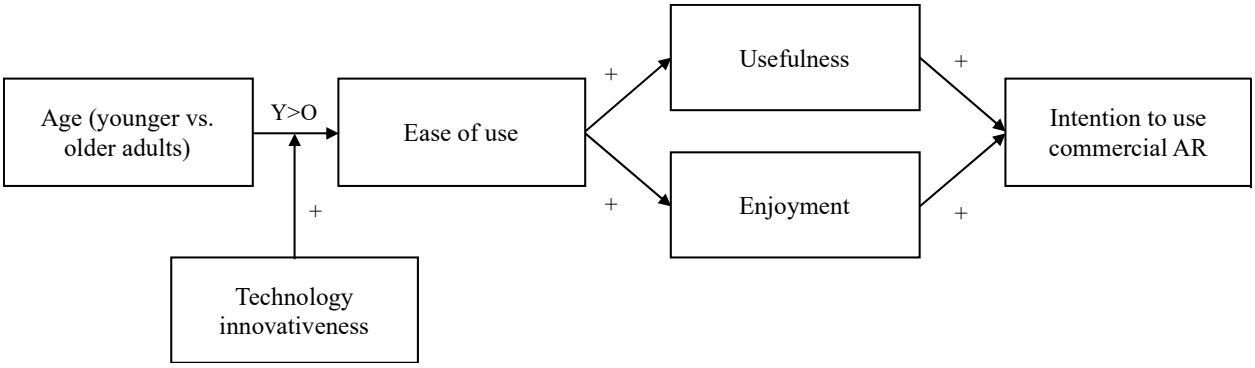
The objective of the study was to examine the influence of both age and technology innovativeness on the intention to adopt commercial AR. A field experiment (N = 71) with a between-subject design was conducted, followed

by a questionnaire. The research population consisted of Dutch individuals who were either younger adults, aged 18-30 (N = 35) or older adults, aged 55-70 (N = 36).

We specifically chose these two age groups for two reasons. First, the current paper was part of a Master's thesis and there was limited time to examine the phenomenon in the participants' homes. By choosing two contrasting age groups, we hoped to find more apparent results. Second, in studies regarding new technologies the older age group was strongly underrepresented compared to younger and middle-aged groups, as if they were excluded as potential targets, even though they are, as mentioned earlier, more and more of interest to marketers. The age of younger and older adults was defined by using the Dutch dictionary (Dikke Van Dalen, 2018), relevant studies (e.g. McClosky, 2006; Chung, Park, Wang, Fulk & McLaughlin, and) and other articles (e.g. Vink, 2015; Naafs, 2016).

A G*power analysis (Cohen, 1988; Selya, Rose, Dierker, Hedeker, Mermelstein, 2012) indicated a minimum sample size of 67 participants (medium effect size, $\alpha = .05$ and power=.95). The participants were recruited using snowball sampling and they were selected through quota sampling. They provided a written informed consent form and received no incentive. It was emphasized to the participants that the data would remain confidential and that they could cease participation at any moment during the research without consequence.

Figure 1. Visual Representation of the Proposed Conceptual Model



Stimuli

All of the participants used an AR smartphone application, called IKEA Place. This app was chosen because it corresponds best with the 'on location' method that this research adopted. The main purpose of the IKEA Place app is to allow people to figure out which furniture fits into their living space by visualizing a virtual 3D product in their own home. Therefore, the living space had to be authentic for each participant, which was achievable only if the experiment was conducted in the participant's home.

Procedure

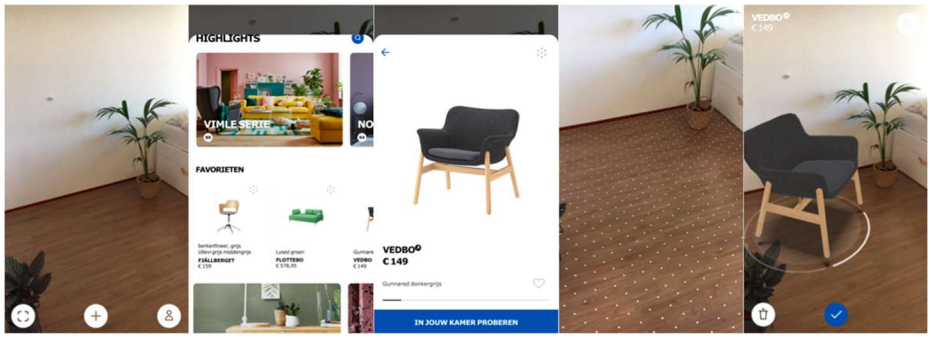
After recruitment, the participants were contacted by the researcher via an information email. Then an appointment at the participant's house was arranged. The visit started with a short information overview (i.e. duration of the research, their rights, and the consent-form procedure) and questions about their affinity with interior design and their general attitude toward IKEA. In order to avoid novelty effects (Hopp

& Gangadgarbatla, 2016) and to introduce participants to the basics of AR technology, they had a practice session of about 7 minutes with another AR app ('Arooound') first. The app purely revolves around simple AR technology; it was not overly amusing, and it was non-commercial in nature. During this practice run, the participants were allowed to ask questions and had the opportunity to raise possible concerns.

Then the participants were given the task to use the IKEA Place app to place a virtual furniture object (either a closet or a sideboard) of their liking in their room. They were told that they had 7 full minutes. With this, they received a list of simple instructions, similar to the ones that IKEA gives to all their new app users, which they were allowed to consult before and during the task. The consumer browsed through the IKEA Place catalog and tapped on the item of their choice. The contours of the physical environment (i.e., floor) were scanned by the camera phone for the application to be able to place the virtual object accurately in the physical space. Once in place, the participant could move the item to the preferred location and rotate it in order to view it from different angles. During the experiment, the participants were free to walk around their room in whatever direction they wished.

The main aim of the task was for the participants to experience AR technology by using the IKEA Place app. Therefore, the researcher was not present in the room while the participants were using the app and did not interfere with the participants' experience. After finishing the task, the participants were asked to fill in a questionnaire about their intention to use the app, the ease of use, usefulness, experienced enjoyment, their previous experience with the app, and socio-demographics (age, gender, and education) respectively. Finally, the participants were debriefed and thanked for their participation.

Figure 2. Impression of the Visualization Process Using the IKEA Place App



Measures

To measure the variables, an existing 7-point Likert scale (1= strongly disagree, 7=strongly agree) was used, unless otherwise specified. This was translated from English into Dutch and checked beforehand with peer-reviewing and think-aloud sessions. The items were deliberately not mirrored to avoid confusion and to keep the survey simple with the older age group in mind.

Age. The independent variable Age was measured by asking the participants about their date of birth.

Intention to use. The dependent variable Intention to use the commercial IKEA Place app was based on the seven-item scale of Huang and Liao (2015). Sample statements included "I would use the IKEA Place app again", and "In the future, I would use this IKEA Place app again" ($\alpha = .97$).

Ease of use. The mediator variable Ease of use was based on the perceived ease of use scale from Huang and Liao (2015). Sample statements included "The use of the IKEA Place app is understandable", and "The IKEA Place app is easy to use" (α = .92).

Usefulness. The mediator Usefulness was based on the media-usefulness scale of Yim et al. (2017). Sample statements included "The IKEA Place app saves me time", and "Overall, I find the IKEA Place app useful in my shopping experience" (α = .86).

Enjoyment. The mediator Enjoyment was measured by the perceived-enjoyment scale of Rese et al. (2017). This scale measures whether people enjoy technology. Sample statements include "I like using the IKEA Place app", and "I derive pleasure in using the IKEA Place app" (α = .84).

Pre-measured product involvement. The control variable Affinity with interior was based on the general involvement scale of Brocato, Baker and Voorhees (2015), with two extra statements in order to measure the buying of furniture and interior decoration. These extra statements were "On average I like to buy interior decoration products", and "On average I like to buy furniture" (α= .94).

Pre-measured brand attitude. The control variable Attitude toward IKEA was based on the overall brand-evaluation scale of Sirianni, Bitner, Brown and Mandel (2013), a 7-point semantic differential scale. A sample question was "Overall, how do you feel about IKEA?" and sample statements included "Dislike – Like" and "Not at all trustworthy – Very trustworthy" (α= .84).

Previous experience with the app. The control variable Previous experience with the app was measured by a single item: "Have you used the IKEA Place app before?" and the answers were yes vs. no.

Gender and education. Participants were asked about their gender ("male", "female", or "different") and their education ("What is the highest level of education that you have completed?").

RESULTS

Control Variables

First, we checked whether the two groups (younger versus older adults) differed on the control variables gender, education, previous app use, product involvement and brand attitude (pre-measure).

Table 1. Sample Characteristics

Variables	Younger adults (N = 35)	Older adults (N = 36)			
	M (SD)	M (SD)	χ^2 (df)	t (df)	*p*
Age	24.00 (2.59)	62.97 (4.51)		-44.51 (56.14)*	.000
Gender			.01 (1)		.909
Male	48.6%	47.2%			
Female	51.4%	52.8%			
Education			7.63 (2)		.022
Low	0.0%	19.4%			
Middle	34.3%	25.0%			
High	65.7%	55.6%			
Previous app use			3.22 (1)		.073
Yes	8.6%	0.0%			
No	91.4%	100.0%			
Product involvement	5.62 (1.16)	5.25 (1.40)		1.21 (69)	.231
Brand attitude (pre-measure)	5.35 (.79)	5.37 (1.05)		-.107 (69)	.915

Note. * *df* differs because equal variances could not be assumed for age.

Table 1 provides an overview of the sample's characteristics. As can be seen from the table, younger adults did not differ from older adults on product involvement and brand attitude. However, the education level differed between the two groups, with the younger adults being more highly educated than the older adults, which is most likely a generation effect. While the difference in previous app use (IKEA Place) was marginally significant, 8.6% of the younger adults had previously used the app, as opposed to 0% in the older adults. Since both education and previous app use did not show any significant correlations with the variables from the hypothesized model, we did not include them as covariates when testing the hypotheses.

Analyses

First, we employed a moderated mediation model using the PROCESS macro from Hayes (2013; model 85; version 3.1) to calculate the direct and indirect effects of age on use intention, via ease of use, usefulness and enjoyment, and the moderation effect of technology innovativeness. Following Hayes (2013), we parameterized the model to correctly estimate the direct effects of the independent variable. This means that the values of the independent variable, Age, were coded as -0.5 (young adults) and 0.5 (older adults). Additionally, the moderator, technology innovativeness, was parameterized by mean-centering this variable. This was done to prevent multicollinearity problems and to correctly interpret the results of the moderated mediation model. This model calculated the direct and indirect effects of age on use intention (via the mediators) at different levels of technology innovativeness (one SD above or below the mean). To assess the indirect effect of age on usefulness and enjoyment (via ease of use), at the different levels of the moderator, two moderated mediation models were employed with either usefulness or enjoyment as the dependent variable (model 7; Hayes, 2013).

Because the moderated mediation models only show the indirect effects at different levels of the moderator, we needed to employ three additional mediation models to calculate the main indirect effect of age on use intention, via ease of use, usefulness and enjoyment, in order to examine H1 and H2. We employed a parallel mediation model (model 6; Hayes, 2013) to analyze the indirect effects of age on use intention, via ease of use, usefulness and enjoyment, and we employed two simple mediation models (model 4; Hayes, 2013) to analyze the indirect effect of age on usefulness and enjoyment, via ease of use. Technology innovativeness was included as a covariate in these models.

For all models, bootstrapping with 5,000 samples was used to calculate 95% bias-corrected bootstrap confidence intervals (BCBCI) for the indirect effects (Hayes, 2013). All direct effects can be found in Table 2 and all indirect effects can be found in Table 3.

Hypotheses

First, we expected that older adults would experience less ease of use when interacting with the AR app than younger adults. The results show that older adults did not differ from younger adults on ease of use. Therefore, H1 is rejected.

Neither was there an indirect effect of age on usefulness and enjoyment, via ease of use. Therefore, intention to use the AR app was also not affected by age. H2 is also rejected. The model does show direct effects of ease of use on both enjoyment and usefulness (see Table 2). Moreover, both enjoyment and usefulness had a positive effect on use intention. Thus, the model does show the previously validated relations according to the TAM model, but there were no differences in the model that were caused by age.

Lastly, we expected that the hypothesized mediation effect of age on intention to use the AR app would be moderated by technology innovativeness. Technology innovativeness shows a significant interaction effect with age,

on ease of use (see Table 2). Figure 3 illustrates the interaction effect at one standard deviation above and below the mean of technology innovativeness. As the figure shows, at low levels of technology innovativeness, older adults score significantly lower on ease of use than younger adults. At the mean level of technology innovativeness, there is no difference. At high levels of technology innovativeness, older adults score (marginally) significantly higher than younger adults on ease of use. Thus, for younger adults, there is no difference in ease of use at low, moderate or high levels of technology innovativeness. For older adults, ease of use is lowest for low levels of technology innovativeness and increases when the level of technology innovativeness increases as well.

When looking at the indirect effects at different levels of technology innovativeness, these show similar results. The indirect effect of age on both usefulness and enjoyment, via ease of use, is significant for low and high levels of technology innovativeness. As shown in Table 3, at low (high) levels of technology innovativeness, older adults score lower (higher) on usefulness and enjoyment than younger adults, via ease of use. For a moderate level of technology innovativeness, there is no significant indirect effect (no difference between the age groups). There are no interaction effects of technology innovativeness and age on usefulness and enjoyment, meaning that the moderated effect of age on usefulness and enjoyment is fully mediated by ease of use.

Additionally, the indirect effect on intention to use the AR app shows the same moderation effect of technology innovativeness. At low (high) levels of technology innovativeness, older adults score lower (higher) on intention to use the AR app than younger adults, via ease of use and consequently, usefulness or enjoyment. Again, this moderated effect is fully mediated via, first, ease of use, and then usefulness and enjoyment.

Table 2. All Direct and Interaction Effects of Age and Technology Innovativeness on Ease of Use, Usefulness, Enjoyment and Use Intention.

	Dependent variables											
	Ease of use			Usefulness			Enjoyment			Use intention		
Predictors	*b*	*SE B*	*p*	*b*	*SE B*	*p*	*b*	*SE B*	*p*	*b*	*SE B*	*p*
Age	-.14 [-.720, .440]	.29	.33	-.14 [-.743, .461]	.30	.64	-.12 [-.528, .293]	.21	.57	-.11 [-.510, .296]	.20	.60
TI	.18 [-.004, .358]	.09	.06	.16 [-.038, .348]	.10	.11	**.21 [.077, .340]**	**.07**	**.00**	**.17 [.029, .306]**	**.07**	**.02**
Age x TI	**.59 [.222, .948]**	**.18**	**.00**	.05 [-.357, .452]	.20	.82	-.01 [-.282, .270]	.14	.97	.09 [-.179, .361]	.14	.50
Ease of use	-	-	-	**.51 [.252, .758]**	**.13**	**.00**	**.87 [.694, 1.039]**	**.09**	**.00**	-.07 [-.338, .198]	.13	.61
Usefulness	-	-	-	-	-	-	-	-	-	**.59 [.414, .770]**	**.09**	**.00**
Enjoyment	-	-	-	-	-	-	-	-	-	**.52 [.262, .783]**	**.13**	**.00**
R^2	.20			.31			.71			.80		

Note. Unstandardized b-coefficients [95% Bias corrected bootstrap confidence interval using 5.000 bootstrap samples between brackets]; SE B = Boot SE; TI = technology innovativeness; significant indirect effects are bold; $N = 71$.

Figure 3. Interaction Effect of Age and Technology Innovativeness on Ease of Use.

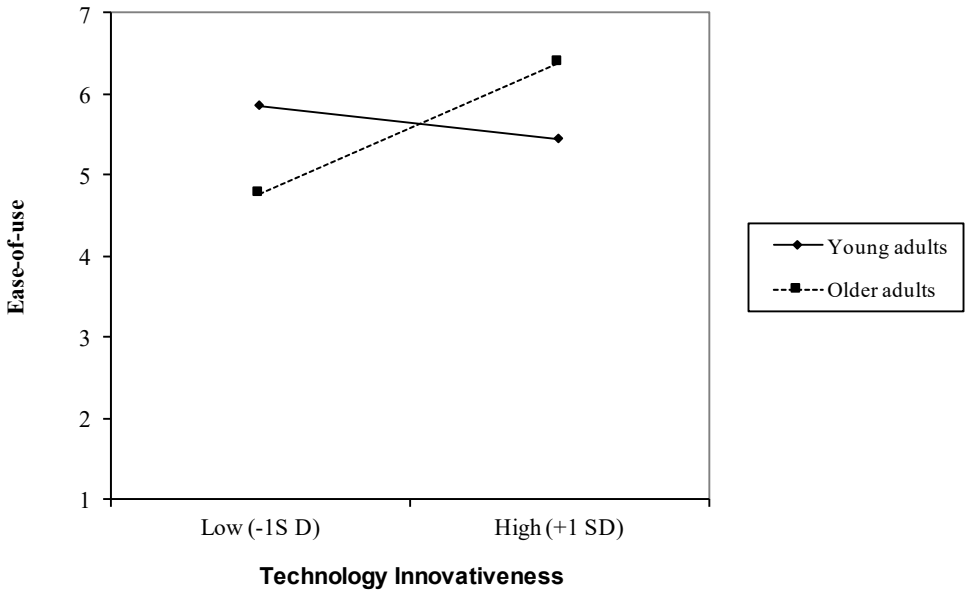


Table 3. Mediation Effects and Moderated Mediation Effects.

	Indirect effect	Boot SE	BootLLCI	BootULCI
Indirect effect: Age → Ease of use → Usefulness				
General indirect effect:	-.06	.16	-.369	.263
Moderation effect:				
Low TI	**-.62**	**.31**	**-1.240**	**-.040**
Moderate TI	-.08	.16	-.383	.255
High TI	**.46**	**.24**	**.088**	**1.008**
Indirect effect: Age → Ease of use → Enjoyment				
General indirect effect:	-.09	.25	-.582	.391
Moderation effect:				
Low TI	**-1.02**	**.45**	**-1.844**	**-.117**
Moderate TI	-.13	.25	-.607	.391
High TI	**.75**	**.34**	**.155**	**1.471**
Indirect effect: Age → Ease of use → Usefulness → Use intention				
General indirect effect:	-.03	.10	-.221	.171
Moderation effect:				
Low TI	**-.33**	**.18**	**-.727**	**-.032**
Moderate TI	-.04	.09	-.208	.168
High TI	**.24**	**.16**	**.031**	**.629**
Indirect effect: Age → Ease of use → Enjoyment → Use intention				
General indirect effect:	.04	.12	-.304	.171

Moderation effect:				
Low TI	**-.49**	**.29**	**-1.156**	**-.038**
Moderate TI	-.06	.14	-.376	.173
High TI	**.37**	**.19**	**.065**	**.804**

Note. Indirect effects are unstandardized b-coefficients; LLCI=Lower Limit Confidence Interval, ULCI= Upper Limit Confidence Interval based on 95% Bias corrected bootstrap confidence interval using 5.000 bootstrap samples; TI = technology innovativeness; significant indirect effects are bold; $N = 71$.

CONCLUSION AND DISCUSSION

This study aimed to determine whether older adults and younger adults, with different levels of technology innovativeness, differ in their intention to use commercial AR. The intention was to contribute to scientific knowledge by examining the influence of individual characteristics of potential users on their intended adoption of commercial AR. Moreover, it aimed to provide marketers and brands with useful information about the application of AR across either younger or older individuals with different levels of technology innovativeness, in order to help them target and segment more efficiently.

At first glance, our findings show that older and younger adults did not differ in their perceived ease of using commercial AR, and subsequently they experienced similar levels of usefulness, enjoyment and intention to use the technology. However, this study has also shown that for older adults, as the level of technology innovativeness increases, so does the ease of use of the AR app. More specifically, older adults with a relatively low technology innovativeness have lower intentions to use commercial AR (as opposed to younger adults), via ease of use and consequently usefulness and enjoyment. The opposite applies to older adults with relatively high technology innovativeness, who ultimately have higher intentions to use the technology as opposed to younger adults. For younger adults, the level of technology innovativeness did not lead to a difference in ease of use, and consequently usefulness, enjoyment and the intention to use AR.

Earlier studies into commercial AR lacked information about how older age groups perceive AR. However, similar to Alelis et al. (2015), this study demonstrated that a specific group of older adults perceived AR surprisingly well. Past research into technology and age has resulted in fairly pessimistic expectations regarding older adults' relevant skills (e.g. Van Deursen & Van Dijk, 2011; Olson et al., 2011) and the amount of expected cognitive obstacles they may encounter when handling new technologies (e.g. Charness & Boot, 2009; Hawthorn, 2000; Salthouse, 2009; Wagner et al., 2010). The current study, however, only partly corresponds to this, by presenting an apparent divide or split in the group of older adults based on their technology innovativeness. A plausible explanation for this is that an older subgroup may be distinguished, similar to the so-called 'silver surfers', embracing novel technologies (Choudrie, Ghinea & Songonuga, 2013; Cody, Dunn, Hoppin & Wendt, 1999) such as AR. These older adults mimic the adoption patterns of younger adults (Olson et al., 2011) and, as shown in the current study, seem to be even more eager to use this technology than the average younger adult. Meanwhile, another subgroup of less technology innovative older adults showed less intention to use commercial AR. This divide is not induced by any chronological age differences between these older adults, but shows evidence for the idea of a cognitive (or subjective) age, which refers to one's self-perceived age (Barak & Schiffman, 1981; Caspi, Daniel & Kavé, 2019; Wei, 2005). The results of the current study align with the notion of Wei (2005), who suggested that target

customers for high-tech products are cognitively younger and dispersed throughout various age groups, not just the chronologically younger. Furthermore, while research has shown that older adults often feel younger than their chronological age, Caspi et al. (2019) reported older adults feeling older after using unfamiliar technology then before. However, the current study may contradict this partly by showing a divide in technology innovativeness. This suggests that less technology innovative older adults may feel older, while more technology innovative older adults feel younger after using new technologies.

Practical Implications

This study provides useful information for brands and marketers who are considering implementing AR to enable consumers to virtually try out their products. Before investing in the development of proper AR content, they like to have some reassurance that their specific target groups are willing to use this form of technology. And although several studies have confirmed AR to be a useful tool for consumers' decision-making process (Huang & Liao, 2015; Hilken et al., 2017; Modak & Sinha, 2019), scarce evidence was available about the influence of important individual characteristics. If marketers wanted to target older adults with a commercial AR app, there were hardly any academic studies to draw conclusions from.

This study gives reasons to assume that both younger adults and more technology innovative older adults are potential users of commercial AR. Both found AR to be relatively easy and consequently useful and enjoyable, and they had higher intentions to use it. Therefore, this study shows that besides young adults, more technology innovative older adults may also be an interesting target group for AR. Meanwhile, AR may not be the right tool for targeting less technology innovative older adults. If marketers are considering targeting this group as potential users for their AR apps, it may be wise to add more detailed instructions in order to inform and guide them smoothly. To confirm this notion, further research should be conducted.

To conclude, it would be advisable for marketers and brands to take into consideration how technology innovative their target group is, or perhaps estimate their cognitive age, rather than only segment on biological age. It seems to be a waste to exclude older adults beforehand and only focus on younger adults as a target group, because some older adults are even more eager to use commercial AR than the average younger adult.

Limitations and Future Studies

There are some limitations to keep in mind when assessing the results of this study. An important note regarding this study is our study design. This study focused on a specific app (IKEA Place), part of a specific product group (furniture). The IKEA Place app was chosen for its accurate visualization, minimal 'bugs' and simplistic nature based purely on the AR try-out function. However, positive attitudes toward strong brands such as IKEA may transfer to the evaluation of the technology (Geuens & De Pelsmacker, 2017). And although we controlled for the attitude toward IKEA, this still raises the question of whether the supposed (positive) findings only apply to strong brands. Future studies could examine whether the same model applies to commercial AR apps of less known brands. In addition, future studies could test the applicability of the model for other commercial AR apps with different products to virtually try out.

Another remark concerns the possibility that novelty effects may be accountable for the participants' relatively high scores on all the determinant factors, perhaps resulting in a ceiling effect. Practically all of the participants (97%) had no previous experience with the use of specific commercial AR apps. Both Hopp and Gangadharbatla (2016) and Yim et al. (2017) warn that this positive stance, due to a

novelty effect, could decrease with time due to familiarization, the so-called wear-out effect. Although we let the participants do a test run with another AR app in order to introduce them to AR technology, this may have not been enough to rule out this novelty effect completely. Therefore, we suggest including participants in the sample who have AR experience or are familiar with the specific AR app in order to test the existence of this ceiling effect.

Another recommendation for future studies is to go beyond the adoption intentions of younger versus older adults, with different levels of technology innovativeness, and to examine if and how persuasive effects differ for these individuals. Although our study is indicative of who is likely to adopt commercial AR, we wonder whether the same individuals would actually buy articles after experiencing them through a commercial AR app. As mentioned before, older adults are a fast-growing proportion of online consumers (CBS, 2018; Lian & Yen, 2014), but previous studies showed that older adults value quality and the opportunity to look and feel before buying (Hough & Kobylanski, 2009; Myers & Lumbers, 2009). They have a so-called high need for touch (Lee, Yang & Johnson, 2017). This may imply that although technology innovative older adults have the intentions to use virtual try-out technology, actual buying will still take place in the physical stores.

A last suggestion for further research is to conduct qualitative research on this specific topic. By conducting focus group sessions, it would be possible to unravel the adoption intentions of both younger and older adults more deeply, enabling the identification of other motivations and causes, beyond the ones introduced by the TAM, for using commercial AR. Identifying these would enable an update of the TAM in the specific AR context. Furthermore, it may even reveal why less technology innovative older adults have less intentions to use the technology, and how this subgroup can be approached in a more fitting way in order to optimize their use of AR apps.

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APPENDIX: QUESTIONNAIRE

Thank you for participating in this study. Participation will take up to 20 minutes. First, you will have to answer two questions, followed by an assignment with a smartphone and finally you will have to complete a questionnaire about this assignment. Please answer according to your opinion and experience. Remember that there are no wrong answers.

The data will be treated confidential and you will remain anonymous. The information will be used for this research only and will be destroyed afterwards. You are participating voluntarily, meaning you are free to stop your participation at any time without any consequences.

For questions prior to the assignment, you can approach the research assistant [name]. During the assignment it is not possible to ask questions, for the sake of research purposes. For questions or comments afterwards, you can send an e-mail to [e-mail address].

First, answer the two following questions.

1. Indicate to what extent you agree with the following statements
   - In general, I have a strong interest in interior
   - Having a nice interior is very important for me
   - Interior matters a lot to me
   - Overall, I like buying interior decorations
   - Having a nice interior is very important to me
   - Overall, I like buying furniture

2. Please choose what applies for you

Overall, how do you feel about IKEA
   - Dislike – Like
   - Not at all trustworthy – Very trustworthy
   - Very low in quality – Very high in quality
   - Not at all appealing – Very appealing

What is the chance of you shopping at IKEA
   - Not at all likely – Very likely

Finished? In a few minutes you will execute an assignment with an app on a smartphone. App is the abbreviation for 'Application'. Programs on a smartphone or tablet are called apps. Smartphones and tablets provide you with standard apps, but you are also able to download some extra apps. 'Whatsapp' and 'Buienradar' are well-known examples.

Before continuing to the app this research is about, you will be practicing with a different app with the help of [assistants name]. She will tell you more about why and how this app works.

Practice App

You practiced with the smartphone app for a bit, now we will start the actual assignment with a different app: the IKEA Place app. With this app you are able to virtually visualize IKEA furniture in your own surroundings. The assignment is as follows:

The Assignment

Imagine you want to update the room you are currently standing in and you are looking for a little cabinet or side table to do so. The app visualizes in true size, but you can focus exclusively on what cabinet or table fits with the interior of your room (colour, shape etc.). Try out the app and look for different options. You get 7 minutes to find one of your liking and visualize it in your own room. The assistant will keep track of the time. After these 7 minutes you will receive the questionnaire, where you have to write down which cabinet or side table you choose.

The assistant [name] will provide you with a separate sheet with simple instruction of how the IKEA Place app works. Read these instructions beforehand, and/or use them during the assignment.

The assistant [name] will hand you the smartphone with the IKEA Place app. Then

you can start your assignment: choose and place a cabinet or side table to your liking.
A quick reminder: the assistant is not available for questions during the assignment.
Good luck!

Assignment

You just completed the assignment. Please answer the following questions about the assignment and your use with the IKEA Place app.

3. You were asked to choose and place a cabinet or side table. What is the name of the item of your liking? If you can't remember the name, please describe it.
4. Indicate to what extent you agree with the following statements
   - I intent to use the IKEA Place app again
   - What is the likelihood that you would use the IKEA Place app again
   - In the future, I would return to use this IKEA Place app
5. Indicate to what extent you agree with the following statements
   - Using the IKEA Place app is understandable
   - Using the IKEA Place app does not require a lot of mental effort
   - The IKEA Place app is easy to use
   - I find it easy to get the IKEA Place app to do what I want it to do
6. Indicate to what extent you agree with the following statements
   - The IKEA Place app enhances my ability to make product choices more effectively
   - Using the IKEA Place app saves me time
   - Using the IKEA Place app improves the quality of my search for products
   - The IKEA Place app enables me to acquire product information more quickly
   - Overall, I find the IKEA Place app useful in my shopping experience
7. Indicate to what extent you agree with the following statements
   - I like using the IKEA Place app
   - The actual use process of the IKEA Place app is pleasant
   - I derive pleasure in using the IKEA Place app
8. Indicate to what extent you agree with the following statements
   - If I heard about a new technology, I would look for ways to experiment with it
   - Among my peers, I am usually the first to try out new technologies
   - I like to experiment with new technologies
9. Have you used this IKEA Place app before the current research? Yes/No
10. What is your date of birth?
11. What is your gender? Male/Female/Other
12. What is your highest education level?

Thank you for your participation! If you are interested in the purpose or results of the research, you can leave your e-mail address with the assistant [name] and will receive an email with the main findings of this study. This address will not be used for any other (research) purposes). Again, in case of any comments or questions, you can send a mail to [mail address]. Thanks again!