Persuasive virtual touch

the effect of artificial social touch versus no touch on shopping behavior in virtual reality

Zhao, Y.

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Technische Universiteit Eindhoven University of Technology

Department of Industrial Engineering and Innovation Science
Human Technology Interaction Group

Persuasive Virtual Touch: The Effect of Artificial Social Touch versus No Touch on Shopping Behavior in Virtual Reality

Master Thesis

Yuguang Zhao

0977499

Supervisors:

Dr. J.R.C. Ham	IEIS, HTI, TU/e
Prof. Dr. W.A. IJsselsteijn	IEIS, HTI, TU/e
Jurgen van der Vlist	Enversed Group B.V.

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Abstract

Virtual reality (VR) technology is developing quickly in contemporary society and has been applied in many domains, such as entertainment, skill training, persuasion and clinical therapies. VR shopping is one of the promising applications. With its multisensory capabilities (visual, but also others, e.g., sound and tactile) VR affords powerful influences on human behavior and thinking. In addition, tactile feedback can increase media richness and improve traditional graphical user interfaces of VR. Previous research found that the Midas touch effect can also be found when using mediated social touch. In addition, earlier research indicated that in a real bookstore, a slight touch on the upper arm increased the shoppers' shopping time, their amount of shopping, as well as their overall evaluation of the store. Based on the Media Equation hypothesis, users' responses to the social cues that artificial social agents in VR display can be comparable to their responses to social cues by humans. Artificial social touch has potential persuasive power and VR shopping can be a huge promising market in near future. However, social touch and tactile feedback are rarely used in current VR applications and it remains unknown that whether artificial social agent can also have similar persuasive power in VR.

To investigate whether artificial social touch in VR can instill similar effects, we set up an experiment in which participants were asked to shop in two virtual shops (in random order). In one shop, the virtual shop assistant touched participants (shoppers) on the upper arm (by means of an actuator on participant's arm) while greeting. In the other shop the virtual shop assistant identically greeted participants, but without touching them.

Results showed that in the shop in which participants were touched by the virtual shop assistant, they spent more time, spent more money on purchasing and their overall shopping experience evaluation was more positive. The results were in line with our hypotheses as well as early research conducted in a real bookstore. These findings confirmed that the illusion of virtual social touch can be established in VR and contributed that VR employing artificial social touch can be effective in influencing consumer behavior.

The results indicated that participants responded to the touch of the virtual assistant as to the touch of a real person. These response seemed to be natural and automatic, which is in line with the proposal of the media equation hypothesis. In addition, similar as in the real world, the effect of interpersonal touch was found in the virtual environment. The tactile feedback of touch increased social cue to the artificial social agent and could help to increase participants' perceived realism.

Content

1. Introduction

Imagine that one day in the near future you are shopping in a Virtual Reality (VR) shop. The virtual shop assistant greets you, and touches you on the upper arm while doing so. You can not only see the virtual assistant but also feel the touch in VR. Would that touch influence your shopping behavior and make you buy more?

Indeed, VR is no longer a new concept in modern society. VR is a computer technology that is often regarded as a natural extension of 3D computer graphics with advanced input and output devices. Sometimes VR is combined with physical spaces or multi-projected environments, to generate realistic images, sounds and other sensations, which gives users a sense of reality (Jayaram, Connacher & Lyons, 1997). Several companies have released their VR equipment in the consumer market, like for instance, Oculus Rift consumer version (Oculus Rift, n.d.), SONY Playstation VR (Playstation VR, n.d.) and HTC Vive (Vive | Discover Virtual Reality Beyond Imagination, n.d.) (see Figure 1.1). This new technology of VR has been used in many domains, not only entertainment, but also for serious purposes, such as skills training (Våpenstad, Hofstad, Langø, Mårvik, & Chmarra, 2013), persuasion (Chittaro & Zangrando, 2010) and clinical therapies (Krijn, Emmelkamp, Olafsson & Biemond, 2004).

Figure 1.1 HTC Vive. From “HTC Vive”, 2017, https://eshop.htc.com/VR/cartOne.html.

Another emerging commercial use of VR is VR shopping, which can be a huge market in the near future. More in general, online shopping is a huge market in contemporary society. In recent decades, the internet has become a widely used transaction medium. From 2001 to 2005, yearly Internet retail sales grows at an average speed of 30% per year (Holzwarth, Janiszewski, & Neumann, 2006). According to eMarketer (2017), the amount of e-commerce sales worldwide in 2016 was 1.86 trillion US dollars, and the amount is expected to grow to 4.48 trillion US dollars in 2021. Still, in traditional online shopping, consumers can only see products pictures on screen. VR technology can boost their shopping experience to a new level. With simply a VR headset, consumers can view the item from every angle, as if the products are in front of them. VR shopping also has several advantages over online shopping.

For example, the virtual environment is much more flexible than physical space. It is easier to change and redesign without high cost. Also, it reduces the possibility of returns which may cost a lot. With VR shopping, consumers can inspect items from every potential angle before purchasing.

Alibaba, for instance, started their VR shopping project "Buy +" in 2016 (CNN, 2016). It uses VR cardboard headsets and interactive 3D space to provide an immersive shopping environment. The prototype was released in November 2016 (CNN, 2016). Consumers can virtually visit large shopping mall like Macy's at home, choose items, check details and purchase with simple operation (see Figure 1.2).

Figure 1.2 Alibaba Buy +. From Alibaba offers VR shopping, CNN, 2016, http://edition.cnn.com/videos/world/2016/11/28/alibaba-vr-shopping-stevens-pkg.cnn.

In traditional retail environments, scientific theories help retailers understand humans' motivations behind their shopping behavior. One of the important theories is the PAD emotional state model proposed by Mehrabian and Russell (1974). PAD stands for pleasure, arousal and dominance (Mehrabian & Russell, 1974). The model indicates that any environment, including that of a retail store, will produce an emotional state in an individual that can be characterized in terms of the three PAD dimensions, which are factorially orthogonal. Among the three factors, pleasure and arousal are significant mediators of intended shopping behaviors within the store (Robert & John, 1982). Robert and John (1982) found in their experiment that pleasure is a very powerful determinant of consumer behaviors within the store, including spending behavior, and that arousal can increase time spent in the store and also willingness to interact with sales personnel (Robert & John, 1982). Pleasure-displeasure refers to the degree to which the person feels good, joyful, happy or satisfied in the situation; arousal-nonarousal refers to the degree to which a person feels excited, stimulated, alert or active in the situation; and dominance-submissiveness refers to the extent to which the individual feels in control of or free to act in the situation (Robert & John, 1982). The third emotional state, however, is not very relevant to in-store behaviors (Robert & John, 1982).

In traditional retail environments, there is evidence that interaction with human sales agents increases satisfaction with a retailer, enhance attitudes toward products sold by the retailer and increase the consumer's intention to buy (Webster, 1968). In the online environment, however, some traditional atmospheric variables are no longer available, for instance, there is lack of direct communication between consumer and shop assistant. To deal with the problem of no direct communication between consumer and shop assistant, an artificial social agent can be used as persuasion agent (Roubroeks, Ham, & Midden, 2011).

Artificial social agents can be used to influence people's behavior or attitudes, just as human agents do in many situations (Roubroeks et al., 2011). People tend to react to computer technology as though it was a real social entity, according to the media equation hypothesis (Reeves & Nass, 1996). This tendency to treat computer technology as a social entity occurs whether the representation of the computer is the screen, a voice, or an agent (Moon, 2000). Relatedly, Social Agency Theory (Mayer, Sobko, & Mautone, 2003) and the Social Cue Hypothesis (Louwerse, Graesser, Lu, & Mitchell, 2005) suggested that the more social cues (e.g., voice, presence of a face, facial expressions) technological systems display, the more social the interaction between a human and the technology becomes (Roubroeks et al., 2011). The interaction will be experienced to a higher degree as a human-human interaction.

Confirming this, Holzwarth and colleagues (2006) found in their study that using a virtual sales agent in an online shop led to more satisfaction with the retailer, a more positive attitude toward the product, and a greater purchase intention (Holzwarth et al., 2006). Virtual sales agents in online environment are proved to have similar ability as real shop assistant (Holzwarth et al., 2006).

Another key factor that can influence the shopper's behavior is interpersonal touch. Touch sense in general is one of the five classic senses. Human can detect different types of stimuli through the sense of touch (Haans & IJsselsteijn, 2006). There are two sub-systems of sense of touch, the cutaneous system and the kinesthetic system. The cutaneous system refers to the different receptors in the skin and their receptive afferents, while the kinesthetic system is responsible for one's awareness of the movement and position of one's limbs in time and space (Haans & IJsselsteijn, 2006).

Besides sense, touch is also crucial in social interaction. Indeed, touch is one of the most primitive means of contact and communication (Furnham & Petrova, 2010). Previous research indicates that people increase their compliance to a request when being touched, even when the request is not made directly (Haans & IJsselsteijn, 2006). For example, Hornik (1987) found that touch both increases the answer rate to a street survey and the compliance in answering in a subsequent questionnaire (Hornik, 1987). Different studies have shown that touch by a waiter or a waitress can increase a person's tipping behavior, known as the Midas touch effect (Crusco & Wetzel, 1984; Lynn, Le & Sherwyn, 1998).

Different types of touch have different meanings. For instance, handshake is one of the most common body signals which can be interpreted as polite and friendly (Furnham & Petrova, 2010). Holding the upper arm while shaking hands is influencing and persuading touch

(Furnham, 2014). Furthermore, to make effective communication, the meaning of what is indicated by the sender should be adequately interpreted by the receiver. Accordingly, effective communication requires at least part of the message should have a common or shared symbolic meaning (Haans & IJsselsteijn, 2006).

In the context of the present study, interpersonal touch in retail market means whether the shopper is touched by shop assistant. Indeed, earlier research suggested that interpersonal touch can influence consumer behavior. According to arousal labeling theory, touching behavior can produce arousal in another person (Patterson, 1976). And arousal level is a key element in PAD emotional state model. In general, earlier research suggested that interpersonal touch can facilitate perceptions of liking and trustworthiness (Hornik, 1991). For example, Mehrabian (1971) found that body contact is a signal of liking and acceptance (Mehrabian, 1971). More specifically, interpersonal touch can also have an influence on consumers' feelings and judgements. Wycoff and Holley (1990) reported that those passengers who were touched by airline flight attendants on the shoulder or forearm increased their liking of the flight attendants and the airline in general. Besides, they also increased their perceived safety during the flight (Wycoff & Holley, 1990).

Showing that social touch can influence consumer shopping behavior, Hornik (1991) conducted an experiment in a book store. When shoppers entered the store, they were first greeted by an experimenter. Half of the shoppers were touched by the experimenters on the upper arm while the other half was not. Their shopping time and total value of purchases were recorded. In addition, they were asked to fill out a brief evaluation of the store. The results indicated a positive main effect of touch on all dependent variables. In other words, those who were touched by experimenters spent more time and more money in the store. They also evaluated the store more positively (Hornik, 1991).

Artificial social touch was used in the present study to simulate physical social touch from shop assistant, since there is no real shop assistant in VR. Artificial social touch is performed by the artificial agent. Similarly, mediated social touch, according to Haans and IJsselsteijn (2006), can be defined as the ability of one actor to touch another actor over a distance by means of tactile feedback technology (Haans & IJsselsteijn, 2006). The Midas touch effect was also found in mediated social touch, using electromechanical stimulation through a tactile display, indicating that electromechanical stimuli were processed in ways similar to actual touch (Haans, de Bruijn & IJsselsteijn, 2014).

Haptic feedback can be used to provide the feeling of being touched by another (virtual) person in VR. Haptic feedback is a crucial sensorial modality in virtual reality interactions (Burdea, 1999). Haptics means both force feedback (simulating object hardness, weight, and inertia) and tactile feedback (simulating surface contact geometry, smoothness, slippage, and temperature) (Burdea, 1999). In the present study, we focus on tactile feedback, more specifically, simulating surface contact. Earlier research indicates that tactile feedback can enhance the realism of virtual environments (Hoffman, 1998). In Hoffman's experiment, participants in the "see only" condition had only visual image of a virtual plate and picked up a real plate with the cyberhand; participants in the "see and touch" condition could see image

of a virtual plate and feel a real plate with their hands. The "see and touch" group reported to feel the virtual environment more realistic.

Based on the theories presented above, we argue that social touch can influence consumer shopping behavior also in VR. More specifically, based on the Media Equation hypothesis (Reeves & Nass, 1996) we argue that users' responses to the social cues that artificial social agents in VR display will be comparable to their responses to social cues by humans. Therefore, just like the human shop assistant in Hornik's (1991) study, artificial social agents using artificial social touch in VR also have persuasive power and can help to increase sales. Interpersonal touch also has persuasive power and helps increase sales.

VR is a powerful simulation tool, it can provide vivid and immersive experiences, which may have advantages for persuasive purposes and influencing behavior, and have positive influence on consumer's purchasing behavior. Artificial social touch has potential persuasive power and VR shopping can be a huge promising market in near future. However, social touch and tactile feedback are rarely used in current VR applications. Therefore, it is important to investigate whether artificial social touch can be effective in VR. Importantly, extending research of persuasion in real life contexts, studying this question in VR allows for very precise identification of the social cues that are effective. That is, the research on the effectiveness of social touch in a real shop leaves open the possibility that in addition to touching, the sales agent used also other social cues in the touch condition. VR technology allows to control all characteristics and behavior of the artificial social agent, ensuring that touch (vs no touch) is the only difference between experimental conditions.

The present study will mainly focus on the effect of interpersonal touch in VR as persuasive technology to influence a particular behavior. Specifically, we will study whether the effects of social touch on shopping behavior (as found by Hornik, 1991) can also be found in VR. To investigate whether indeed, the artificial touch is experienced as artificial social touch, we will compare the effects of artificial social touch (the shop assistant touching consumers on the upper arm) to no touch.

Therefore, research question can be formulated as following:

> *What is the effect of artificial social touch versus no touch on (shopping) behavior in virtual reality?*

The hypotheses were formulated as below:

> *H1: Participants who are touched by the artificial agent in VR will spend more time in the virtual shop.*
>
> *H2: Participants who are touched by the artificial agent in VR will spend more money in the virtual shop.*
>
> *H3: Participants who are touched by the artificial agent in VR will evaluate their shopping experience more positively.*

2. Method

2.1 Participants

Participants were recruited via Facebook, among TU/e students and among visitors at Enversed VR Center. There were 44 adult participants in total involved (30 male and 14 female, 28 Chinese, 10 Dutch, 2 Irish, 2 American, 1 Indonesian and 1 Slovak). All of them came to Enversed VR Center to participate the experiment. A power analysis indicated that a sample size of 44 was necessary, to provide 90% power when a medium effect size $f = 0.25$, with an alpha error level of $p < 0.05$.

2.2 Experiment Design

To test the three hypotheses mentioned in the previous section, a 2 cell within subject study was performed. The independent variable in the present study was type of touch (touch versus no touch). The three dependent variables in the experiment design were the time they spend in the virtual shop, the money they spent in the virtual shop and their evaluation of the shopping experience. In conclusion, the present study had a 2 (touch versus no touch) by 3 (time, price and evaluation) within subjects design

Participants were asked to visit three virtual shops. The first one was a training room (see Figure 2.1) where they learned the basic operations of picking up items in VR, checking out and answering questions in VR. The other two were a stationery shop (see Figure 2.3) and a book shop (see Figure 2.4). After the training room participants experienced both experiment condition and control condition in a random order. In the experimental condition, participants were touched by the virtual shop assistant on the left upper arm. In the control condition, participants were not touched. The experiment condition was assigned randomly to either the stationery shop or the book shop. In each condition, the time they stayed in the shop and the money they spent were recorded. A set of questions were used to measure participants' evaluation. After the two conditions, participants indicated their presence, the gender and their VR experience before the present experiment.

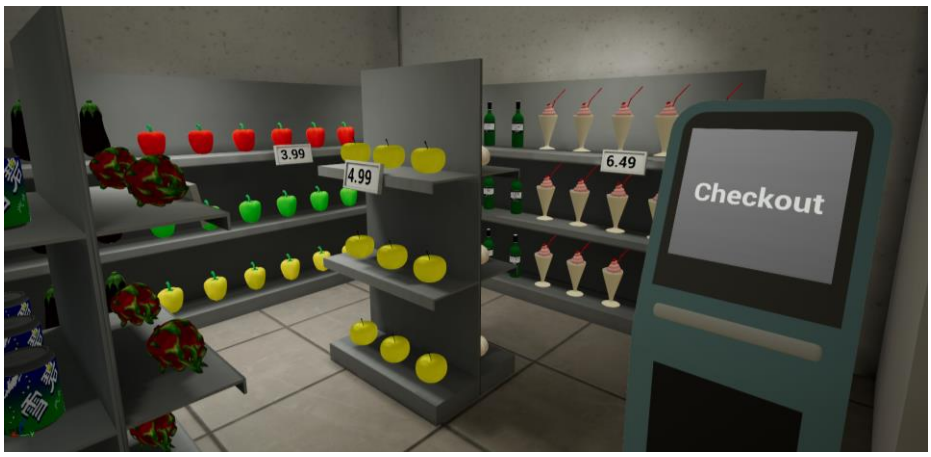

Figure 2.1 Grocery store (training room)

2.3 Procedure

It took each participant 10 to 15 minutes to finish the experiment procedure. First they were informed of the aim and the process of the experiment by the experimenter. Then they signed the consent form. Next, they were led to the starting point, put on the VR headset and the headphones. Finally, the experimenter started the VR shopping program and gave the controllers to participants.

Participants were asked to visit three virtual shops. The first one was a training room where they learned the basic operations of picking up items in VR, checking out and answering questions in VR. Then participants experienced both experimental condition and control condition in a random order. Participants were instructed to buy one item in each shop and try to control the money they spent (in each shop) to around € 4.50.

As figure 2.5 shows, participants started at position A in both conditions. First, the virtual (female) shop assistant was at position B, facing the participant. The virtual shopping assistant greeted the participant. In the experimental condition, the virtual shop assistant greeted the participants, saying "Welcome to our store," at the entrance and touched them on the left upper arm. In the control condition, the virtual shop assistant greeted the participants, saying "Welcome to our store," but refrained from any touching behavior.

After greeting, the virtual shop assistant walked to the corner of the shop (position C in Figure 2.5) and stayed there looking around casually for the remainder of the shopping experience. Participants could start shopping after being greeted. They were free to walk around in the virtual shop and choose one item. There was a self checkout machine by the entrance. When participants finished shopping in one virtual shop, they came back to the entrance/exit (position A), and checked out by touching the screen of the checkout machine (see Figure 2.1). In this way, participants returned to the starting point (position A in Figure 2.5) and would have the same physical space to move around in the next virtual shop as the previous one.

In each condition, the time they stayed in the shop and the money they spent were automatically recorded by the system. After each shop, participants were kindly asked to answer a few questions in VR, to evaluate the shop, the shop assistant and the shopping experience. Participants were automatically directed to the question room in VR (see Figure 2.2) after checking out. The questions were posted on the wall, and participants indicated the answers by using the Vive controllers (Vive | Discover Virtual Reality Beyond Imagination, n.d.). After the seven questions, participants were directed automatically to the starting point of the next shop. In this way, participants did not need to put off the VR headset, and the VR experience were not interrupted. After finishing both conditions, participants indicated their presence, the gender and their VR experience before the present experiment.

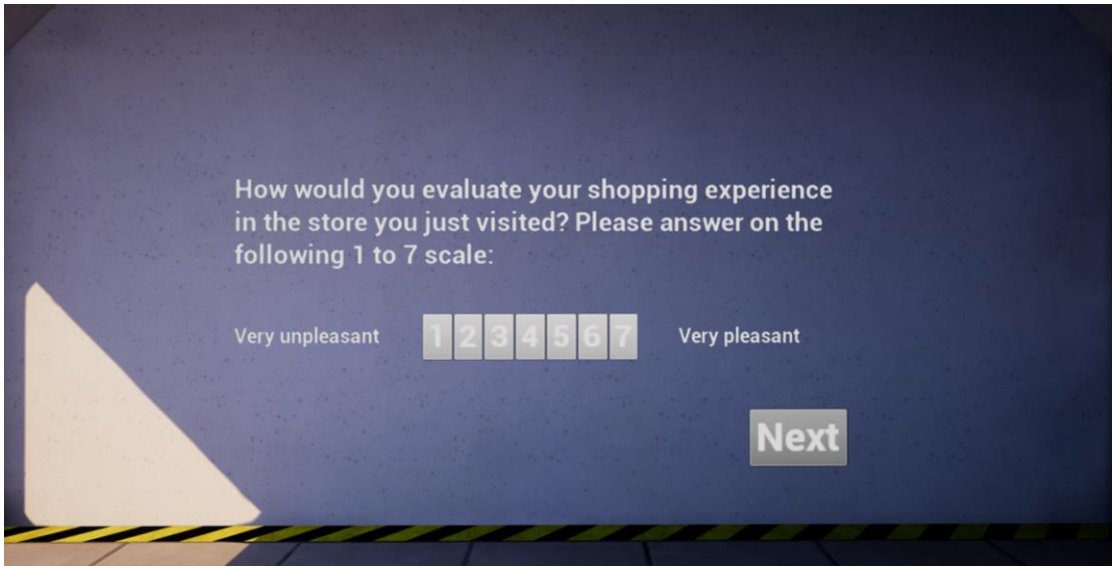

Figure 2.2 Question interface in VR

2.4 Materials

The three virtual shops were created in Unreal Engine 4. Each of them has a (virtual and real) dimension of 5 meters by 4 meters. See Figure 2.1, Figure 2.3 and Figure 2.4, in which the training room, the stationery shop and the book shop are depicted.

There were 7 shelves in each shops, all with 3 levels. According to the real grocery shop setup, the width of the shelves were set to 35 cm. All the items on the shelves could be picked up in VR using the HTC Vive controller (Vive | Discover Virtual Reality Beyond Imagination, n.d.). A self checkout machine was located by the entrance of each shop. Participants could check out by touching the virtual screen (see Figure 2.1, the gray area marked with “checkout”).

Figure 2.3 Stationery shop

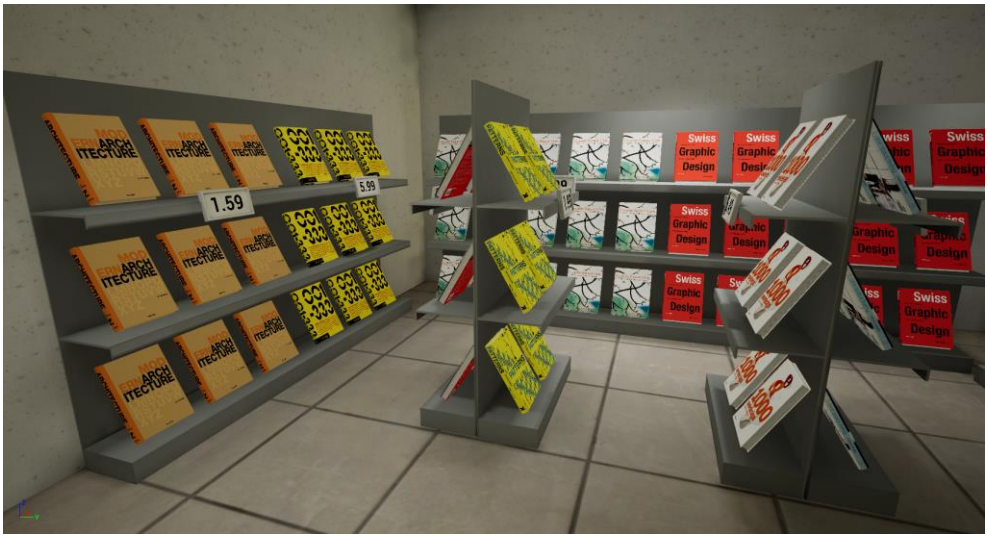

Figure 2.4 Book shop

The three shops shared the same floor plan, grid layout (see Figure 2.5). According to conventional retailing store layout theory (Levy & Weitz, 2001), there are three major types of store layout: grid layout (also known as straight layout), freeform layout and racetrack/boutique layout (Vrechopoulos, O'keefe, Doukidis & Siomkos, 2004). The grid layout is a rectangular arrangement of displays and long aisles that generally run parallel to one another. Previous studies indicate that the grid layout facilitates routine and planned shopping behavior, providing consumers with flexibility and speed in identifying pre-selected products which appear on their shopping list (Levy & Weitz, 2001). It is commonly used in grocery stores, book stores and convenience stores.

To make sure each item in the virtual shops has even exposure, endcaps were not used in the present study. Thereby, there was no advantage for certain items. Endcaps are displays of products located at the end of an aisle or row of shelving in a supermarket (Levy and Weitz, 2009). Endcaps have the ability to prompt sales increases and high prevalence relative to other forms of in-store media (Sorensen, 2009).

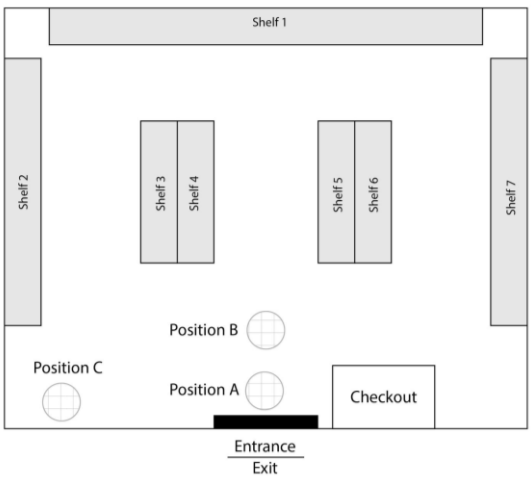

Figure 2.5 Floor plan

Stationery shop and book shop were chosen because the items in these shops were relatively neutral. Personal preference would not play an important role in the shopping process. There were 10 kinds of items in each shop. The price range in the three shops was identical (from €1.59 to €7.99) with same average price (M = 4.4, SD = 2.02).

Two different female shop assistants were used in the present study. They were created such that they looked like real shop assistants and avoid uncanny valley (see Figure 2.6). The shop assistant greeted participants when they entered the shop. In the experimental condition, the shop assistant touched participants' upper arm while greeting. In the control condition, the shop assistants only greeted participants without touch. After greeting, the virtual shop assistant walked to the corner of the shop (position C in Figure 2.5) and stayed there.

Figure 2.6 Shop assistant

To provide the feeling of being touched, we designed and developed a special armband controlled by a microprocessor and with a small motor on it (see Figure 2.7). All the components were attached to a stretchy armband. The stretchy armband and the self adhesive strap provided enough flexibility so that the armband could fit different participants. The touching arm was 41mm long, 3.5mm thick and was attached to the motor. It rotated 60 degrees and provided 0.08 N force on the arm. The armband was synchronized with the animation of the virtual shop assistant. When the virtual assistant raised her arm and reached participants' upper arm, the system triggered the motor on the armband. So that participants could have the feeling of being touched. Participants were asked to wear the armband during the experiment.

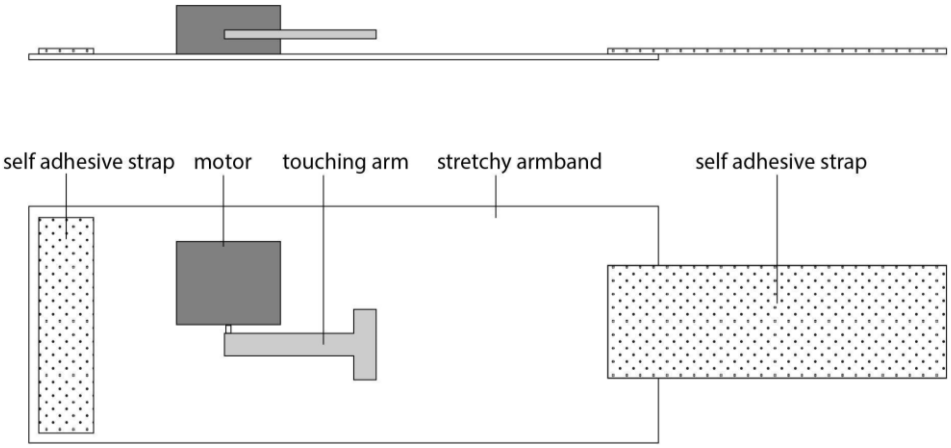

Figure 2.7 Special armband to provide the feeling of touch

Background music was used in the experiment. Earlier research indicates that music has influence on purchasing behavior. Smith and Curnow (1966) found that the volume of music influenced shopping time. Shoppers spent significantly shorter time in the load condition (Smith & Curnow, 1966). Areni and Kim (1993) found that music type influenced money spent in the shop. Shoppers spent more money in the classical music condition than the pop music condition (Areni & Kim, 1993).

To limit the influence of the music on shopping behavior, the present study used piano pieces in low volume, identical in all three shops. The music file consisted of several piano pieces lasted for thirty minutes. It was played on an over-ear headphones that plugged to the VR headset. The music created the atmosphere that close to real shops. The volume of the music did not interfered the virtual shop assistant's voice, but loud enough to cover the sound of motor on the touching armband.

2.4 Measures

The shopping time was automatically recorded by the VR system we built. It started when the participants entered a virtual shop and ended when they checked out. The money they spent in each store was also recorded.

To measure the evaluation by the participant of the shop and the shopping experience, a set of questions were used in the experiment. A variation of Self-Assessment Manikin (SAM) Scale (Bradley & Lang, 1994) was used to measure the pleasure and arousal level of participants. SAM has been used effectively to measure emotional responses in different situations, including reactions to images (Miller, Levin, Kozak, Cook, McLean & Lang, 1987) and sounds (Bradley, 1994). The original scales were image based (see Figure 2.8). Since image based scales are not friendly to be implied in VR and in order to keep consistency of all the scales used in the present study, the original scales were transformed into verbal form. After each virtual shop, participants were asked to answer the following question in VR: how would you evaluate your shopping experience in the store you just visited on the following scales from (a)1 (very unpleasant) to 7 (very pleasant) and (b) from 1 (not very exciting) to 7 (very exciting).

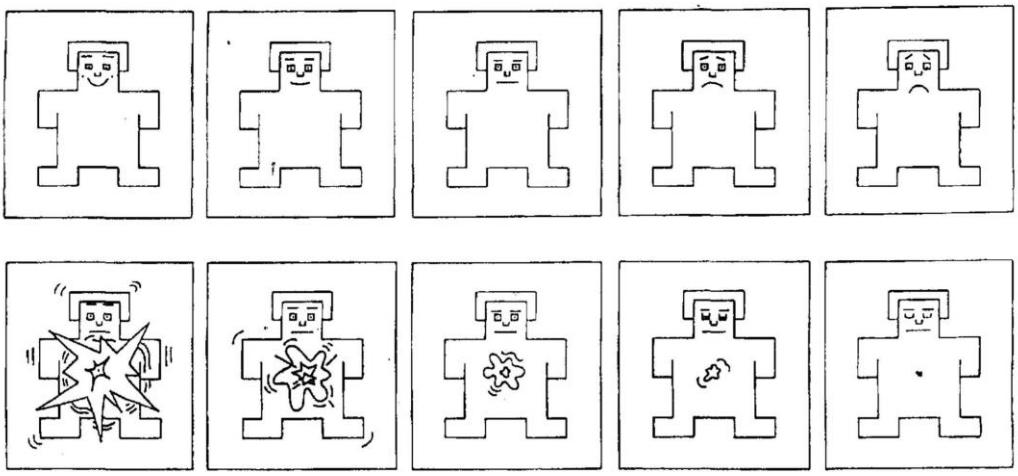

Figure 2.8 Self-Assessment Manikin Scale

Then participants were asked (c) how would you evaluate the store you just visited on the following scale from 1 (very unsatisfied) to 7 (very satisfied) and (d) how would you evaluate the shop assistant in the store you just visited on the following scale from 1 (very negative) to 7 (very positive).

Finally, participants were asked to rate their impression of the virtual shop assistant. The standard measurement of perceived anthropomorphism was used (Bartneck, Kulić, Croft & Zoghbi, 2009). Participants were asked to rate their impression of the virtual shop assistant on the following scales: (e) from 1 (fake) to 7 (natural); (f) from 1 (machinelike) to 7 (humanlike) and (g) from 1 (unconscious) to 7 (conscious).

There were seven questions in total. The factor analysis showed high correlation among the seven scales. By averaging these seven questions, we constructed a reliable measure (*cronbach's alpha* = 0.835) of overall shopping experience evaluation.

3. Results

3.1 Method

Multivariate analysis of variance (MANOVA) was used as the main data analysis method in the present study. MANOVA is a procedure for comparing multivariate sample means. As a multivariate procedure, it is used when there are two or more dependent variables (Warne, 2014). It is followed by significance tests involving individual dependent variables separately, which help to answer (a) do changes in the independent variable have significant effects on the dependent variables; and (b) What are the relationships among the independent variables (Stevens, 2002). The present study had a 2 (touch: touch versus no touch) x 3 (variable: time, price and evaluation) within subjects design. There was one independent variable and three dependent variables. The effect of the independent variable on dependent variables will be investigated. As a result, MANOVA was chosen as the main data analysis method in the present study.

3.2 Hypotheses testing

As expected, the main effect of touch was found for the three dependent variables: results provided evidence that the time participants spent in the virtual shop was longer, the money participants spent in the virtual shop was more, and participants' overall evaluation of the shopping experience was higher, when a participant was touched as compared to when the participant was not touched by the artificial social agent, indicated by a main effect of touch, $F(1,43) = 4.60$, $p = .038$. Results provided no evidence that this main effect was different for the three types of dependent measures (time, money, and evaluation), as results showed no interaction of touch by type of dependent variable, $F < 1$.

Table 1 Means and standard deviations for each dependent variable by touch and no touch. Means with different subscripts differ significantly from each other at $p < .05$

				95% Confidence Interval	
Measure	Touch	Mean	Std. Error	Lower Bound	Upper Bound
Time	touch	83.12_a	4.96	73.13	93.10
	no touch	75.64_b	4.25	67.06	84.22
Price	touch	5.81_a	.38	5.05	6.56
	no touch	5.02_b	.29	4.44	5.60
Evaluation	touch	4.81_a	.15	4.52	5.11
	no touch	4.32_b	.16	4.00	4.63

Table 1 presents the means and standard deviations for each dependent variable by touch versus no touch.

More specifically, first, when a participant was touched by the artificial agent in a VR shop, he or she spent *more time* (M = 83.12s, SD = 32.84) in the shop than where he or she was not touched (M = 75.64s, SD = 28.21), indicated by the simple effect of touch for shopping time $F(1,43) = 3.39$, $p = .072$.

Second, when a participant was touched by the artificial agent in a VR shop, he or she spent *more money* (M = 5.81, SD = 2.49) in that shop than where he or she was not touched (M = 5.02, SD = 1.90), indicated by the simple effect of touch for money spent $F(1,43) = 4.37$, $p = .043$.

Third, when a participant was touched by the artificial agent in a VR shop, he or she *evaluated the shopping experience in that shop more positively* (M = 4.81, SD = .96) than where he or she was not touched (M = 4.31, SD = 1.03), indicated by the simple effect of touch for overall evaluation $F(1,43) = 15.46$, $p < .001$.

3.3 Exploratory Analyses

Importantly, to analyze the effect of order, we performed the following analysis. A 2 (shop type) by 2 (touch versus no touch) by 3 (time, price and evaluation) MANOVA was performed. The results provided no evidence that the order in which participants visited the store in which they were touched and the store in which they were not touched influenced the average price of the object they bought, the time they spent in the shop or their evaluation of the shop, as results showed no effect of order (shop type), $F(1,43) = 1.02$, $p = .319$.

A detailed analysis of the effect of our touch manipulation on the various questions of the evaluation measure was also performed. Results showed that when a participant was touched by the artificial agent in a VR shop, he or she evaluated the shopping experience as more pleasant (M = 5.68, SD = .98) than where he was not touched (M = 5.27, SD = 1.16), $F(1,43) = 4.75$, $p = .035$. When a participant was touched by the artificial agent in a VR shop, he evaluated the shop assistant more positively (M = 5.05, SD = 1.22) than where he was not touched (M = 4.25, SD = 1.43), $F(1,43) = 15.51$, $p < .001$. When a participant was touched by the artificial agent in a VR shop, he perceived the shop assistant (artificial agent) as more natural (M = 4.30, SD = 1.80) than where he was not touched (M = 3.64, SD = 1.80), $F(1,43) = 8.40$, $p = .006$. When a participant was touched by the artificial agent in a VR shop, he perceived the shop assistant (artificial agent) as more humanlike (M = 4.11, SD = 1.69) than where he was not touched (M = 3.43, SD = 1.69), $F(1,43) = 9.21$, $p = .004$. Touch has significant influence on scales mentioned above.

However, different from what we expected, when a participant was touched by the artificial agent in a VR shop, he did not evaluate the shopping experience as more exciting (M = 5.30, SD = 1.30) than when he was not touched (M = 5.05, SD = 1.38), $F(1,43) = 1.18$, $p = .283$.

Furthermore, results also showed that participants' behavior towards touch were different in the two shops. The two way interaction of shop type (book shop and stationery shop) by touch type (touch and no touch) was found.

More specifically, first, when a participant was touched by the artificial agent in the stationery shop, he or she spent *more time* (M = 85.71s, SD = 35.04) in the shop than when he or she was not touched (M = 71.87s, SD = 30.83), indicated by the interaction effect of touch and shop type for shopping time $F(1,42) = 5.42$, $p = .025$. No significant interaction effect for shopping time was found in the book shop $F < 1$. See Figure 3.1.

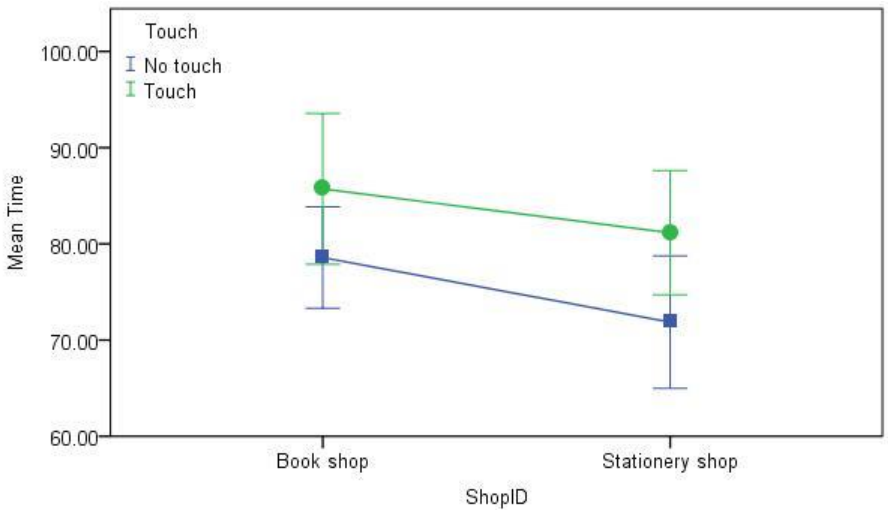

Figure 3.1 Interaction effect of touch and shop type for shopping time

Second, when a participant was touched by the artificial agent in the book shop, he or she spent *more money* (M = 6.05, SD = 2.76) in the shop than when he or she was not touched (M = 4.52, SD = 1.31), indicated by the interaction effect of touch and shop type for shopping time $F(1,42) = 9.76$, $p = .003$. No significant interaction effect for shopping time was found in the stationery shop $F < 1$. See Figure 3.2.

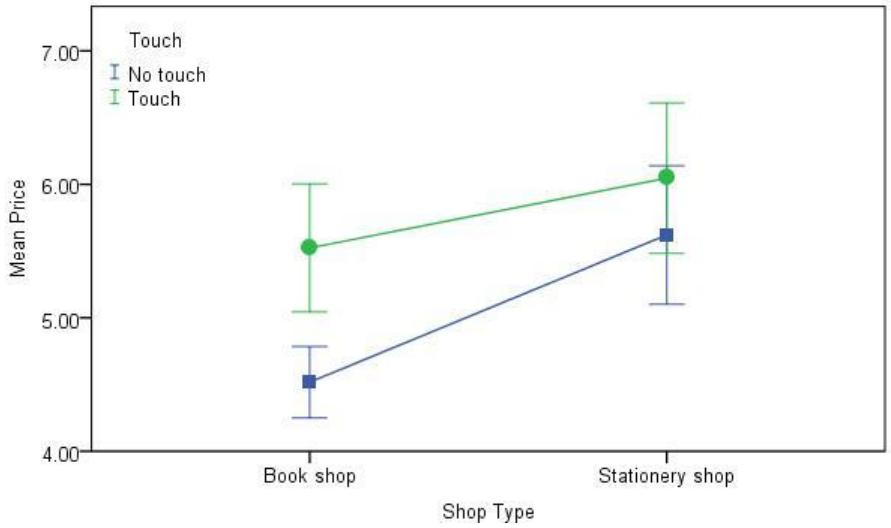

Figure 3.2 Interaction effect of touch and shop type for money spent

Third, no significant interaction effect of touch and shop type for overall evaluation was found. In the book shop, participants *evaluated the shopping experience in that shop more positively* (M = 4.83, SD = 1.03) than where he or she was not touched (M = 4.44, SD =.87), indicated by the simple effect of touch for overall evaluation $F(1,42) = 5.46$, $p = .024$. In the stationery shop, participants *evaluated the shopping experience in that shop more positively* (M = 4.78, SD =.92) than where he or she was not touched (M = 4.18, SD =1.21), indicated by the simple effect of touch for overall evaluation $F(1,42) = 10.55$, $p = .002$.

4. Conclusion & Discussion

VR technology is developing fast in the recent years and has been applied in many domains, such as entertainment, skill training, persuasion and clinical therapies. In addition, VR shopping is another huge emerging market and VR technology has the potential of having a huge impact on it. In traditional retail market, shop assistant and interpersonal touch were used to influence consumer behavior and increase sales. It was unknown that if similar effects can be found in VR. Earlier research by Hornik (1991) found that in a real bookstore, a slight touch by a shop assistant on the shoppers' upper arm increased the shoppers' shopping time, their amount of shopping, as well as their overall evaluation of the store. Artificial social touch has potential persuasive power and VR shopping can be a huge promising market in near future. However, social touch and tactile feedback are rarely used in current VR applications. Whether (artificial) social touch can have similar effects in VR remained unknown. Therefore, the present study investigated the effects of artificial social touch versus no touch on shopping behavior in VR.

To investigate this question, we set up an experiment in which participants were asked to shop in two virtual shops. In one shop the virtual shop assistant touched participants (shoppers) on the upper arm while greeting. In the other shop the virtual shop assistant identically greeted participants, refraining from any touch. Participants experienced the touch and no touch conditions in a random order.

The results showed that when participants were touched by the virtual shop assistant in one of the virtual shops, they spent more time in that shop, spent more money on purchasing and the overall evaluation of the shopping experience was more positive. The results were in line with our hypotheses as well as early research by Hornik (1991) conducted in a real bookstore. In the study conducted by Hornik (1991), participants were touched by experimenters at the entrance of a bookstore. Comparable to our findings, participants in Hornik's (1991) study who were touched by experimenters spent more time and more money in the store and also evaluated the store more positively.

The present study was conducted in VR and participants were touched by a virtual shop assistant. The results indicated that participants responded to the touch of the virtual assistant as to the touch of a real person. Some participants replied to the virtual shop assistant's greeting by saying "Thank you". Some participants glanced towards the virtual shop assistant during shopping and checkout. Thereby, results confirmed the media equation hypothesis (Reeves & Nass, 1996). Participants of different gender and from different countries responded socially to the virtual agent. These response seemed to be natural and automatic, which is in line with the proposal of the media equation hypothesis (Reeves & Nass, 1996) that social behavior towards technology is mainly automatic, uncontrolled behavior.

So, similar as in the real world, the effect of interpersonal touch was found in the virtual environment. The tactile feedback increased social cue to the artificial social agent and could help to increase participants' perceived realism. In many current VR applications, there are only visual and audio channels. Tactile feedback can increase media richness and improve

traditional graphical user interfaces. The addition of a tactile channel to communication devices can also enhance or enrich mediated communication (Haans & IJsselsteijn, 2006).

4.1 Application

Since artificial social touch has influence on consumers' purchasing behavior in VR and VR shopping is an emerging market, virtual shop assistants can be applied in virtual shopping environment. They have the potential to increase sales, shopping time and consumers' evaluation of the virtual shop. Previous research found that the Midas touch effect can also be found when using mediated social touch (Haans, de Bruijn & IJsselsteijn, 2014). The present study confirmed that artificial social touch can also increase shopping time and sales by combining visual cues with tactile feedback, similar as the effect Hornik (1991) found in a real book store. The present study suggested that artificial social touch could be used in VR, especially in VR shopping. The artificial social touch can increase the persuasive power of the virtual shop assistant.

The tactile feedback in the present study increased social cue to the artificial social agent and could help to increase perceived realism in VR. However, it was not very easy to achieve. First, the synchronization of the physical touch and the visual stimuli of touch is important. If the physical touch comes earlier or later than the visual stimuli, it can result the abnormal feature of the virtual agent. Second, the artificial touch should have the right pressure. The force and the size of the touching arm are important to make the artificial touch close to real touch from another person. Third, the duration of the artificial touch matters. If the touch is either too long or too short, it feels strange. Fourth, the touching device should be lightweight so that users are relatively unaware of wearing it.

4.2 Limitation and Future research

The two way interaction of shop type (book shop and stationery shop) by touch type (touch and no touch) was found in the results. First, when a participant was touched by the artificial agent, he or she spent more time in the stationery shop than when he or she was not touched, no significant effect of touch on shopping time was found in the book shop. Second, when a participant was touched by the artificial agent, he or she spent more money in the book shop than when he or she was not touched, no significant effect of touch on money spent was found in the stationery shop. A possible explanation can be that: (a) In the book shop, all the items had similar shape and size, the only difference was the covers. All the items were similar to each other and were not so appealing. As a result, participants did not stay significantly longer in the book shop if being touched. However, due to the same reason that all the books were similar to each other, so that participants' choice were less likely to be influenced by personal preferences. As a result, when being touched, participants significantly spent more money in the book shop. (b) In the stationery shop, in contrary, items were quite different from each other. The stationery shop was less "boring" than the book shop. As a result, when being touched, participants spent more time in the stationery shop. Due to the same reason that items had good diversity, so that participants' purchase could be

influenced more by their personal preferences. As a result, when being touched, participants did not spend significantly more money.

Future research can investigate various issues in more detail. First, the present study had an unbalanced gender ratio. It is unknown that whether the effect of artificial social touch differs between male and female. Previous research indicated that female respond more positively than male to being touched (Stier & Hall, 1984). Future research can investigate the effect of touch on different genders.

Second, although the effect of touch was found, the underlying psychological mechanism still remained unclear. A possible explanation in line with the media equation hypothesis (Reeves & Nass, 1996) is that the virtual shop assistant was treated as a social entity, and the virtual shop assistant influences consumers as real sales person. In addition, tactile feedback can potentially increase shoppers' sense of presence (Haans & IJsselsteijn, 2006). It is possible that the increased sense of presence made the virtual environment closer to real world, so that similar effect as found by Hornik (1991) was also found in the present study. A different type of explanation is that the feeling of touch increased the arousal level of participants. According to arousal labeling theory, touching behavior can produce arousal in another person (Patterson, 1976). And arousal can increase time spent in the store and also willingness to interact with sales personnel (Robert & John, 1982). So that they stayed longer in the virtual shop and purchased more. Future research can focus on the underlying mechanism by including more condition, namely the non-social touch condition.

Third, the meaning of touch can differ from culture to culture. Interpersonal touch can be used as a way of nonverbal communication. In order to make the communication effective, the meaning of touch indicated by the sender should be adequately interpreted by the receiver (Haans & IJsselsteijn, 2006). In other words, at least part of the message should have a common or shared symbolic meaning (Haans & IJsselsteijn, 2006). It is kind of a social norm within a group of people. The participants of the present study were mainly Dutch and Chinese, and it is possible that the meaning of touch can differ in other regions and cultures. Future research can investigate the effect of interpersonal touch among different cultures.

4.3 Conclusion

In sum, the present research shows that artificial social touch influences consumers' purchasing behavior by increasing their shopping time, the money they spent and the overall evaluation of their shopping experience. Now VR technology is used in many domains and VR shopping is an emerging market, artificial social agent can be used in VR shopping to influence consumers' purchasing behavior.

Imagine in the near future, if you are shopping in a VR shop. The virtual shop assistant greets you, and touches you on the upper arm while doing so. You can see the virtual assistant, hear her voice and also feel the touch in VR. Current results show that this artificial social touch may make you stay longer in the VR shop, spent more money and evaluate the shopping experience more positively.

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