UNIVERSITY OF
EASTERN FINLAND

# Imagination in compensating for the sense of touch in a virtual environment

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Master's Thesis
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30.04.2024

University of Eastern Finland, Faculty of Social Sciences and Business Studies
Business School
Service Management
Jaskari, Ella H.M.: Imagination in compensating for the sense of touch in a virtual environment
Master's Thesis, 90 pages, 1 appendix (3 pages)
Supervisors: Assistant Professor Heli Hallikainen & Doctoral Researcher Nino Ruusunen
April 2024

**Keywords**: Digital sensory marketing, imagination, haptic imagery, virtual reality, virtual shopping, need for touch

Lack of touch is one of the greatest challenges for online stores, especially in product categories where haptics have an essential role in product evaluation. Product presentations in traditional online stores do not fully communicate the sensory cues related to them, which can lead to frustration, dissatisfactory purchases, and increased returns. With virtual reality becoming more accessible, developing virtual shopping environments and product experiences has started to gain attention. Virtual reality technologies are suggested to overcome the limitations of online shopping by offering a richer sensory experience.

The aim of this study is to examine how consumers' imagination can compensate for the sense of touch in a virtual environment. The role of imagination in virtual shopping is studied by examining the effect of haptic imagery on sense of presence in a virtual store, and the moderating effects of individual's need for touch and imagination. The data collection was conducted with an online survey, targeting students from the University of Eastern Finland (UEF). The final sample of 220 consumers was analysed with a confirmatory factor analysis on SPSS AMOS 29, and a moderation analysis on PROCESS Macro for SPSS.

The results show that haptic imagery has a highly significant positive effect on sense of presence, indicating that consumers with more vivid haptic imagery experienced stronger sense of presence in the virtual store. However, the results did not show statistically significant moderating effects for the concepts of need for touch or imagination. By examining the effects of chosen control variables, it was found that touch screen devices had a positive effect on the outcome of the analysis compared to non-touch screen devices.

This study contributes to the research on consumer behaviour and digital sensory marketing by demonstrating the effect of vivid haptic imagery on sense of presence, and thus provides better understanding on how consumer's imagination affects the virtual shopping experience. The findings support the connection from vivid technology to vivid imagination, and further to stronger sense of presence in virtual environments.

Itä-Suomen yliopisto, Yhteiskuntatieteiden ja kauppatieteiden tiedekunta
Kauppatieteiden laitos
Palvelujohtaminen
Jaskari, Ella H.M.: Mielikuvitus kosketusaistin kompensoimisessa virtuaaliympäristössä
Maisterin opinnäytetutkielma, 90 sivua, 1 liite (3 sivua)
Tutkielman ohjaajat: Yliopistotutkija Heli Hallikainen & Väitöskirjatutkija Nino Ruusunen
Huhtikuu 2024

**Asiasanat**: Digi-aistimarkkinointi, mielikuvitus, haptinen mielikuvitus, virtuaalitodellisuus, virtuaalishoppailu, need for touch

Kosketuksen puute on yksi verkkokauppojen suurimpia haasteita, erityisesti tuotekategorioissa, joissa kosketuksella on keskeinen rooli tuotearvioinnissa. Tuote-esittelyt perinteisissä verkkokaupoissa eivät täysin viesti niihin liittyviä aistivihjeitä, mikä voi johtaa turhautumiseen, epätyydyttäviin ostoksiin ja kasvaneisiin palautuksiin. Virtuaalitodellisuuden tullessa saavutettavammaksi, virtuaalisten ostoympäristöjen ja tuotekokemusten kehittäminen on alkanut saada huomiota. Virtuaalitodellisuusteknologioita on ehdotettu voittamaan verkkoshoppailua koskevat rajoitteet tarjoamalla rikkaamman aistikokemuksen.

Tämän tutkimuksen tavoitteena on tutkia miten kuluttajien mielikuvitus voi kompensoida kosketusaistia virtuaaliympäristössä. Mielikuvituksen roolia virtuaalishoppailussa tutkitaan tarkastelemalla haptisen mielikuvituksen vaikutusta läsnäolon tunteeseen (sense of presence) virtuaalikaupassa, sekä yksilön need for touchin ja mielikuvituksen moderoivia vaikutuksia. Tiedonkeruu toteutettiin verkkokyselyllä Itä-Suomen yliopiston (UEF) opiskelijoille. Lopullinen 220 kuluttajan otos analysoitiin konfirmatorisella faktorianalyysillä SPSS AMOS 29:ssa, ja moderaatioanalyysillä PROCESS Macro for SPSS:ssa.

Tulokset osoittavat, että haptisella mielikuvituksella on erittäin merkitsevä positiivinen vaikutus läsnäolon tunteeseen, mikä osoittaa, että kuluttajat, joilla on eloisampi haptinen mielikuvitus kokivat vahvemman läsnäolon tunteen virtuaalikaupassa. Tulokset eivät kuitenkaan osoittaneet tilastollisesti merkitseviä moderoivia vaikutuksia need for touchin tai mielikuvituksen käsitteille. Tutkimalla valittujen kontrollimuuttujien vaikutuksia havaittiin, että kosketusnäyttölaitteilla oli positiivinen vaikutus analyysin tulokseen verrattuna ei-kosketusnäyttölaitteisiin.

Tämä tutkimus edistää kuluttajakäyttäytymisen ja digitaalisen aistimarkkinoinnin tutkimusta osoittamalla eloisan haptisen mielikuvituksen yhteyden läsnäolon tunteeseen, ja näin antaa parempaa ymmärrystä siitä, miten kuluttajan mielikuvitus vaikuttaa virtuaaliseen ostokokemukseen. Löydökset tukevat yhteyttä elävästä teknologiasta eloisaan mielikuvitukseen, ja edelleen vahvempaan läsnäolon tunteeseen virtuaaliympäristöissä.

## Abbreviations

| | |
|---|---|
| AR | Augmented reality |
| CFA | Confirmatory Factor Analysis |
| HMD | Head-mounted display |
| NFT | Need for Touch |
| VR | Virtual Reality |

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# 1 Introduction

## 1.1 Background

With shopping increasingly shifting online, examining consumer behaviour in online settings and creating better online experiences has become a topic of interest in marketing research. Especially with the Covid-19 pandemic, online shopping has reached an unprecedented level (McKinsey & Company 2021; Jongsun & Jisoo 2021), which has led retailers to seek for ways to create better digital experiences (Serravalle, Viassone & Del Chiappa 2022), and to respond to the changes in consumers' shopping habits (Kim, Kim, Park & Yoo 2023). One notable issue with online stores is the inability to physically examine the products. Limited stimuli for human senses, especially the sense of touch, affects consumers' sensory experience (Ruusunen, Hallikainen & Laukkanen 2023). Touch has an important role in consumer behaviour and purchase decisions as it provides consumers with information about the product, as well as enjoyable sensory feedback (Peck, Barger & Webb 2013). According to Peck et al. (2013), consumers are likely to experience uncertainty due to the lack of haptic sensory input in online environments, especially in product categories like clothing, where haptics have an important role in product evaluation. Consumers who require haptic information to make purchase decisions experience deprivation while shopping online, and in fact about 70 % of US consumers prefer physical stores due to the lack of haptics in online stores (TimeTrade 2017; Gatter, Hüttl-Maack & Rauschnabel 2021). In Europe, despite the growth of online shopping, over 80 % of sales still take place in physical stores (Kaupan liitto 2023). Consumers' preference for haptics can also be seen in the increasing engagement in "showrooming", where consumers only purchase products online after visiting a showroom to physically examine them first (Moes & van Vliet 2017).

Haptic information influences consumers' perceptions (Krishna, Elder & Caldara 2010), and lack of it can even distract accurate visual perception of spatial features (Krishna 2008; Madzharov, Block & Morrin 2015). Lack of sensory feedback makes it difficult for consumers to picture the products in their own homes, which can lead to dissatisfaction in the purchase experience, and returns of online purchases (Heller, Chylinski, de Ruyter, Mahr & Keeling 2019). In traditional online environments, there is a notable imbalance in information as consumers examine products through two-dimensional images that do not fully communicate the sensory cues related to them (Cowan & Ketron 2019). Consumers often feel that the visualizations and information provided of e-commerce products do not represent reality, and therefore include a risk (Hamacher & Buchkremer 2022). The inability to provide consumers with a complete multisensory experience presents a challenge for online retailing (Citrin, Stem, Spangenberg & Clark 2003; Song, Fiore & Park 2007) and requires ways to compensate for this lack of information.

During the restrictions of Covid-19 pandemic, many consumers became aware of the importance of touch in their purchase process (Serravalle et al. 2022). The rise of online shopping during that time forced consumers to find new ways to evaluate products, which led to increased interest towards new technologies. Developing virtual product experiences has gained a lot of attention recently as it aims to overcome the limitations online shopping has regarding consumers' ability to experience and feel products (Liu, Jiang & Chan 2019). Realistic product visualizations such as 3D applications and augmented reality (AR), could contribute to a more compelling online experience (Overmars & Poels 2015). Virtual reality (VR) is considered one of today's technological megatrends, and large retailers such as Amazon, eBay, IKEA, and Volvo have successfully incorporated elements of virtual reality into their e-commerce (Meißner, Pfeiffer, Peukert, Dietrich & Pfeiffer 2020; Xi & Hamari 2021; Kim et al. 2023). Virtual reality enables the creation of a realistic, multi-sensory shopping experience (Jongsun & Jisoo 2021), which could decrease the perceived risk of purchasing products without testing and experiencing them beforehand (Cowan & Ketron 2019). As virtual reality is becoming more accessible, companies are increasingly venturing the possibilities interactive 3D technology has to offer for their online customers (Kang, Shin & Ponto 2020). Efficient VR is suggested to result in better brand attitudes and increased purchase intentions (Choi, Ko & Kim 2016), as well as comfort in decision making, and overall customer satisfaction (Gatter et al. 2021).

The benefits of VR result from the richer sensory experience compared to traditional online shopping environments (Poncin & Mimoun 2014). Multi-sensory technologies and visual activation of memory have been suggested as tools to overcome the lack of physical examination (Serravalle et al. 2022). Assessment of haptic information is largely influenced by visuals, such as visual texture and shape (Sample, Hagtvedt & Brasel 2020). Previous research has suggested that vivid visual stimuli could activate consumer's imagination (Cowan & Ketron 2019; Gatter et al. 2021) and through that, lead to tactile sensations (Overmars & Poels 2015). Imagining is a cognitive process where previously attained information is represented in the working memory (Peck et al. 2013). Seeing a certain product activates past sensorial experiences and assists in imagining its usage and sensorial features (Petit, Velasco & Spence 2019). Realistic content provided with technologies of extended reality, such as VR or AR, is suggested to satisfy consumer's desire to touch, to a certain extent, with the power of consumer's imagination (Gatter et al. 2021). Imagined experience of sensory stimulus has been found in previous studies to produce a very similar perception to real sensory stimulus (Barsalou 2008; Peck et al. 2013). Therefore, in a visually stimulating VR environment, consumers could imagine the haptic properties of the products.

In this thesis, the role of imagination in compensating for the sense of touch in a visually stimulating virtual environment is studied by examining the effects of need for touch and imagination on perceived sense of presence. Sense of presence describes the degree of psychological immersion to a mediated environment (Kim & Biocca 1997), and its ability to "replace" reality (Cowan, Spielmann, Horn and Griffart 2021). The interplay between need for touch and imagination in a virtual environment has previously been studied by Ruusunen et al. (2023). They found that imagination was able to compensate for the lack of touch in a 360-virtual store. However, further research on the capabilities of imagination in compensating for missing sensory perceptions in virtual environments is still needed.

## 1.2 Research questions and aim of the study

The research on VR technologies in retail is increasing (Xi & Hamari 2021), however the focus in current research has mainly been on the performance of the technology, examining aspects such as vividness and interactivity (Lee, Yoon & Choi 2022). Consumer behaviour and consumers' psychological responses to VR technology and VR shopping have yet been given less attention (Han, An, Han & Lee 2020; Lee et al. 2022). In addition, marketers have focused largely on the sense of vision (Krishna 2012; Haase & Wiedmann 2018; Cowan & Ketron 2019), to which online sensory interaction has also been mostly limited to (Petit et al. 2019). However, consumers' sensory perception is the result of all five senses (Haase & Wiedmann 2018). The sense of touch is hard to simulate in virtual settings (Peck et al. 2013; Cowan & Ketron 2019) yet is found to be a significant factor in the shopping experience, for instance in terms of perceived value of products, and the price consumers are willing to pay for them (Peck & Shu 2009). Visual stimuli are suggested to compensate for missing sensory stimuli through consumer's imagination and imagined sensorial sensations (Overmars & Poels 2015; Cowan & Ketron 2019; Petit et al. 2019; Gatter et al. 2021). With technology-based interactions taking over physical product interactions, it has come significant to understand how these imagined sensory experiences could affect consumers' behaviour (Elder & Krishna 2022).

This thesis aims to contribute to the research on consumer behaviour and digital sensory marketing by increasing the understanding of the role of imagination in virtual shopping. The purpose of this thesis is to examine how consumer's imagination can compensate for the sense of touch in a virtual shopping environment. To reach the aims of this study, the following research questions were formed.

The main research question is:

*How does imagination compensate for the lack of touch in a virtual environment?*

This thesis aims to answer the main research question with the help of following sub-questions:

*How does haptic imagery relate to sense of presence in a virtual environment?*

*How does need for touch (NFT) shape the relationship between haptic imagery and sense of presence?*

*How does imagination shape the effect of need for touch (NFT) on the relationship between haptic imagery and sense of presence?*

## 1.3 Key concepts

**Sensory marketing** can be defined as “marketing that engages the consumers’ senses and affects their perception, judgment and behavior” (Krishna 2012). Sensory marketing represents how companies can differentiate through sensory experiences based on emotional, cognitive, and value-based elements (Hultén 2015, 119). It also enables the creation of subconscious triggers that appeal to the senses and contribute to engaging consumers (Krishna 2012). A sensory experience is the combination of all five human senses, and it can form consciously or unconsciously, with impacts on consumer’s behaviour and perception (Hultén 2011; Hultén 2015, 95; Haase & Wiedmann 2018). In **digital sensory marketing** consumers are offered sensory stimuli, such as visual imagery and videos, audio content, and text-based content in online settings (Rose, Clark, Samouel & Hair 2012).

**Need for touch (NFT)** is a scale developed by Peck and Childers (2003) to measure individual’s motivation to acquire information through the haptic system. NFT is further divided into two dimensions of instrumental and autotelic NFT. Instrumental dimension of NFT represents goal-oriented motives for individual’s touch-behaviour. Consumers with instrumental NFT use touch to evaluate products and their features before making a purchase decision. Autotelic NFT on the other hand, represents hedonic motives, and using touch for enjoyment. Consumers with autotelic NFT do not necessarily have a purchase goal, but instead seek for pleasurable sensory experiences and fun through the sense of touch.

**Virtual environments** are computer-generated environments that enable users to control and interact with the environment (Cowan & Ketron 2019). They are applications of virtual reality (VR), and can be accessed through smartphones, computer monitors, or wearable VR-devices, such as head-mounted displays (HMDs) (Jongsun & Jisoo 2021). With the increase of online shopping, various brands have opened **virtual shopping environments** that utilize immersive and interactive elements (McDowell 2020). Virtual environments enable better consumer engagement (Cowan & Ketron 2019), novel digital experiences (Lee et al. 2022), as well as the ability to test store designs or examine consumer behaviour (Meißner, Pfeiffer, Pfeiffer & Oppewal 2019).

**Sense of presence** describes the psychological sense of being in the virtual environment (Slater & Wilbur 1997) and the extent to which the virtual world replaces reality (Cowan et al. 2021). According to Burdea and Coiffet (2003), virtual reality presence is defined through interactivity, immersion, and imagination. Sense of presence is affected by both technological factors, such as immersive virtual elements (Cowan & Ketron 2019), and psychological factors, such as the user's imagination (Lee 2018). All media types can provide sense of presence; however, the extent of it differs depending on the media. Previous research has suggested that the strongest sense of presence is provided with immersive virtual reality (Verhagen, Vonkeman, Feldberg and Verhagen 2014; Moes & van Vliet 2017; Bogicevic, Seo, Kandampully, Liu, and Rudd 2019).

**Imagination** is the ability to mentally envision objects and events (Pearson 2019). Mental imagery results from previously obtained information that is combined with new sensory information from the surrounding environment (Cowan et al. 2021). According to Peck et al. (2013), imagining is a cognitive process where the previously attained information is represented in the working memory. **Haptic imagery** is a sensory dimension of imagination (Liu et al. 2019). It is the mental imagery of touching an item and imagining its haptic features (Lee & Choi 2021). Haptic imagery can happen unintentionally, and it is triggered by a representation of an item

(Petit et al. 2019). Exposure to the representation activates a simulation of previously obtained sensory information from the memory, causing a similar sensation as the initial experience (Peck et al. 2013).

## 1.4 Structure

This thesis consists of five main chapters. The first chapter introduced the background to the topic of this thesis, as well as the aims of the study, and the research questions this thesis aspires to answer. This chapter also presented brief descriptions of the key concepts presented more closely in the following chapter of the theoretical background.

The second chapter presents the theoretical background of this study with a comprehensive review of previously conducted research related to the concepts of this thesis. The chapter examines sensory marketing and the role of touch in consumer's shopping experience, virtual reality and virtual environments as shopping platforms, as well as imagination and the significance of haptic imagery in virtual settings. This chapter aims to form an understanding of the concepts of this study and their relationships. At the end of the chapter, the hypotheses and the research model are presented.

The third chapter addresses the empirical research. This chapter discusses the choice of a quantitative research method and the formation of the survey questionnaire for the data collection. It also presents the implementation of the data collection and the processing of the data prior to analysis. At the end of the chapter, a confirmatory factor analysis is conducted, and the primary analysis method of the study is introduced.

The fourth chapter presents the results of the analysis and the main findings of the study. The theoretical conclusions and managerial implications, as well as the limitations of the study and suggestions for future research are discussed in the fifth chapter.

# 2 Theoretical background

## 2.1 Sensory marketing

### 2.1.1 Sensory experience

The way consumers perceive their surroundings and experience environments is affected by ambient stimuli (Hultén 2015, 124-125). Individual's sensory experience is controlled by both rational and emotional factors, as well as conscious and unconscious (Hultén 2015, 95). Many companies have discovered that subconscious sensory triggers could be an efficient way to appeal to consumers and communicate abstract concepts of their products, such as quality or sophistication (Krishna 2012). Swedish grocery retail chain, ICA, has adopted product labels that describe the sensorial attributes of their produce with the choice of words, for instance, "succulent seabass" instead of "seabass filet". High-class hotel chains have created signature scents in hopes that their customers will associate them with the quality features of the hotel. Vehicle manufacturer Volvo developed their model S80 with technology that sucks the air out of the car when opened, to avoid unpleasant smells (Hultén 2011). Product shapes and textures are designed to appeal to the human senses and stand out from competitors (Krishna 2012). This available sensory information has significant effects on consumers' behaviour, affecting for example, attitudes and purchase intentions (Petit, Cheok, Spence, Velasco & Karunanayaka 2015; Hamacher & Buchkremer 2022), as well as perceived value of products (Krishna 2012). Subconscious sensory triggers can even result in self-generated brand features in the minds of consumers (Krishna 2012).

The definition of sensory marketing can vary slightly depending on the perspective. Hultén (2015, 106) defines sensory marketing as "a service process that focuses on sensory strategies and stimuli with the goal of creating a multi-sensory brand-experience, in supporting the individual's identity creation through the mind and the five senses". A well-known definition by Krishna (2012), on the other hand, defines sensory marketing from consumers' perspective as marketing that engages consumer's minds and affects their perceptions, judgement and behaviour. Kaushik and Gokhale (2022) define sensory marketing simply as “marketing of senses”. According to Hultén (2015, 95), the seek for sensory experience is not just about the consumption of products, but identity creation and self-fulfilment through the experience. By this definition, sensory marketing focuses on consumer value, consumer experience, and brand image, based on the human senses. In a multi-sensory experience, more than one of the senses are involved in the formation of a perception (Kaushik & Gokhale 2022). A sensory experience that engages multiple senses generates better customer value and brand image (Hultén 2011). Sensory marketing is also connected to neurosciences, as consumer’s behaviour is the result of how the sensory input affects their brain, and how this information is perceived and analysed (Hultén 2015, 139). The functions of how different information and stimuli affect the human brain, and how this further affects decision-making and consumer behaviour, is studied in the research area of neuromarketing (Hultén 2015, 161-162).

Senses are used to retrieve information from the surrounding environment but can also use information from memories connected to the sense (Hultén 2015, 105), and affect the perception of other sensorial features. Consumers evaluate product quality and performance based on both internal cues, such as looks, taste or texture, and external cues, like brand name or price (Citrin et al. 2003), and these cues influence the evaluation of other cues. For example, Krishna and Morrin (2008) found consumers to rate the same drink better-tasting when it was served from a firm cup compared to a flimsy one. They also found that even an imagined feel of a firm container resulted in a judgement that the drink is of better quality. As opposed to a sensation, which occurs when the stimulus reaches receptor cells of a sensory organ, perception is awareness and understanding of sensory information (Krishna 2012). Perception is believed to be based on individual experiences and knowledge (Hultén 2015, 140) and can therefore vary between individuals. In the above example, consumers have associated a firm container with good quality, probably based on previous experience, which affects their perception of the taste of the drink. The role of perception in sensory marketing is presented in Figure 1.

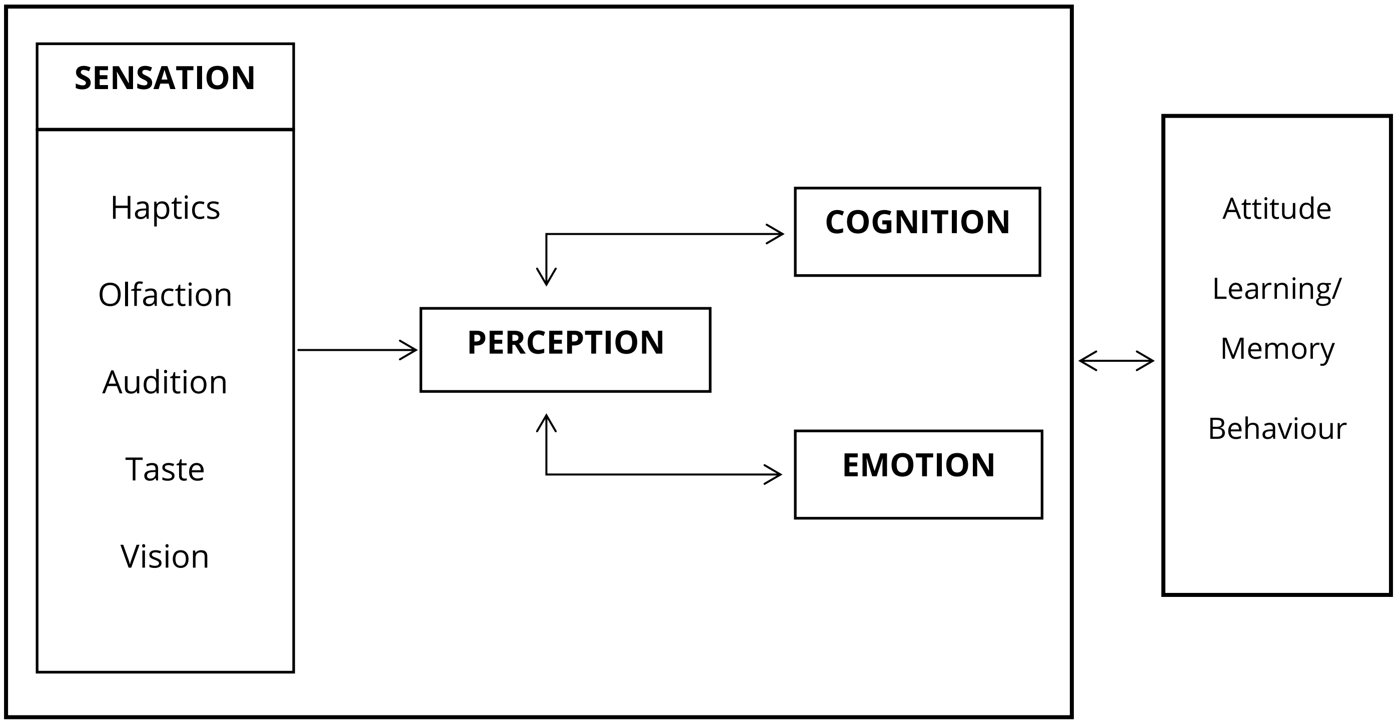


**Figure 1.** Conceptual framework of sensory marketing. (Krishna 2012)

Sensory marketing strategies intend to express and differentiate a product or service according to the human mind and senses, as well as define brand identity and values (Hultén 2011). In a study examining the sensorial strategies of companies, Hultén (2011) found that strategies focusing on sight were considered the most significant in expressing brand identity and value. Visuals have usually been the main focus in marketing (Haase & Wiedmann 2018), although consumer's experience is based on all five senses. The sense of sight is seen as the prevalent sense for observing the environment and perceiving objects (Hultén 2011), but it often requires combining with other senses to achieve a tangible experience (Kaushik & Gokhale 2022). Some research has been conducted on the importance of different senses in the context of product evaluation. Schifferstein and Cleiren (2005) investigated the role of sensory modalities of vision, touch, audition, and olfaction on product experiences. The participants examined different products through only one of the sensory modalities and described the sensory experience, awakened memories and associations, and lastly identified the product. Vision and touch were found to be the strongest senses when it comes to the ease of product identification, recalling past experiences, and making associations to other products and people. In another research by Schifferstein (2006), participants rated vision to be the most important sense for evaluating products, followed by touch as the second important sense, and olfaction, audition, and taste as less important senses. However, it is suggested that the importance of a certain sense depends on the evaluated product. For instance, when evaluating clothing items, cosmetics, and the ease of use, touch was rated as the most important sense. Schifferstein (2006) also found that on average, women rate the importance of all five sensory modalities higher than men.

Service environment, whether a physical store or an online environment, has an important role for the sensory experience and therefore, consumers' behaviour and attitudes. The design of a store has been found to lead to interactions with products that otherwise would have been ignored (Hultén 2015, 318). Accordingly, even the feeling of a chair in a restaurant can affect customers' judgement of the whole brand (Hultén 2015, 117). Poncin and Mimoun (2014) have found that a sensory experience with positive effects on consumers' mood increases the amount of money they spend while shopping. The effect of a pleasant atmosphere has also been demonstrated in a study by Hultén (2012). Pleasant atmosphere, created with sensory cues, was found to impact consumer's touch behaviour and purchasing of products. The study was conducted in the glass department of IKEA, where the atmosphere was modified with visual and olfactory sensory cues. A pleasant atmosphere encouraged consumers to stay longer in the department and to touch the products, leading to increased purchases.

### 2.1.2 Online sensory experience and lack of touch

Online customer experience consists of sensorial, emotional, cognitive, pragmatic, lifestyle, and relational components (Rose et al. 2012). The main forms of sensory stimuli in online environments are visual and auditorial elements (Kaushik & Gokhale 2022), which consumers process through cognitive and affective processes to form an impression (Rose et al. 2012). According to Kaushik and Gokhale (2022), consumers' interactions with products and brands in online environments are mainly related to mental images and perceptions, rather than self-assessments, due to limited sensory information. Sensory marketing has provided a substantial advantage for offline environments as consumers can make entirely hedonic decisions based on the physical experience of a product (Kaushik & Gokhale 2022), which is harder to achieve in online environments. The sense of touch is a three-dimensional sense as it adds information beyond sight about qualities such as firmness, shape and texture (Hultén 2015, 304). An example presented by Hultén is how it is natural for many consumers to pick up a bread at the store to evaluate whether it is fresh or not. According to Hultén (2015, 117), if products are not physically available it is easier for consumers to bypass them. Physically available products, and the ability to touch them, have a better chance at getting consumer's attention and lead to unplanned purchases.

Limited sensory stimuli in online settings affects especially the interaction with products, as the inability to physically examine them complicates the formation of a tangible image in consumer's mind (Kaushik & Gokhale 2022). The lack of desired sensory stimuli is referred to as "online sensory deprivation" and can cause customers to feel frustrated and bored (Hamacher & Buchkremer 2022). Products that require a multisensory evaluation are usually less likely to be purchased online (Citrin et al. 2003), as online purchases can turn out to be different from what the customer had pictured (Kaushik & Gokhale 2022). Yazdanparast and Spears (2013) have found the frustration caused by the lack of sensory information to decrease with improvements to consumer's mood. According to them, good mood could be achieved by focusing on the layout and visual aspects of the e-commerce store, as well as using humoristic and sensory-rich content. In fact, "fun" is found to be an important factor when shopping for clothes and shoes online (Lester, Forman & Loyd 2005). Klatzky and Peck (2012) have also introduced the concept of "touch-ability", which stands for the features of an object that attract consumers to touch it. They found that certain features, such as smoothness and simpler shapes, were more inviting to touch, compared to rough textures and complex shapes. Klatzky and Peck (2012) suggest that retailers could benefit from consumers' perception of touch-ability in online environments as well.

Other suggested methods to overcome the lack of touch include for instance, videos that demonstrate how fabrics move, online fittings through avatars, and with the newest technology, even tablets that allow consumers to feel fabric materials from vibrations on the screen (Moes & van Vliet 2017). On e-commerce websites, high-quality images from different angles are emphasized as essential for multi-sensory consumer engagement (Hamacher & Buchkremer 2022). However, according to Kaushik and Gokhale (2022), overcoming the problem of intangibility in online environments requires more than images. They argue that touch, or even imagined touch, is the most important factor in increasing the perception of tangibility. Petit et al. (2019) have suggested that "webmospheres", as in online environments with a pleasant atmosphere, could with the support of sensory-enabling technologies (SETs), lead to consumers imagining the sensory properties of products without the need for actual sensory stimuli, and thus increase the confidence in product choices. They define SETs to include already commonly used devices, such as touch screens and headphones, but also VR and AR technology, as well as digital sense interfaces, which are not yet as commercialized.

Hamacher and Buchkremer (2022) have examined the sensorial properties of e-commerce websites with an online sensory marketing index (OSMI) that measures sensory output of the sites and identifies areas for improvement. The index measures the stimuli for all five senses and weighs the scores depending on the industry. For instance, haptics weigh more in the fashion industry than in healthcare, and olfactory information is more important in cosmetics than technology. The index was tested on 16 e-commerce websites from different industries and revealed that text-based sensory stimulation, as well as high-quality images taken from multiple angles, were utilized on almost all 16 websites. However, a first-person perspective, which would increase imaginings of haptic features in the context of static images, was utilized on only three websites. Furthermore, 3D product visualizations, product videos, and virtual try-on's have not yet been widely adopted.

### 2.1.3 Need for touch (NFT)

Need for touch (NFT) refers to the preference of utilizing information acquired through the haptic system (Peck & Childers 2003). It is a multi-dimensional construct that is further divided into two dimensions: instrumental and autotelic need for touch. Consumers' need for touch influences how they evaluate the haptic features of products, such as their texture or weight (Alzayat & Lee 2021). The degree of one's need for touch describes the individual level of motivation to examine haptic features of products, and thus varies among consumers (Peck & Childers 2003). Consumers with higher NFT are more confident in their product judgements when they can touch products before purchasing, whereas consumers with lower NFT are less affected by the lack of haptic information, and base their confidence for example, on visual examination (Peck & Childers 2003). Consequently, consumers' high NFT is suggested to have a negative effect on the appeal of online shopping (Kühn, Lichters & Krey 2020; Ruusunen et al. 2023). A study by Citrin et al. (2003) found consumers' need for haptic input to have a significant negative effect for online shopping of items that usually require haptic cues for evaluation, such as clothing.

High NFT has been associated with consumer behaviour such as fashion enthusiasm (Workman 2010), and impulsive buying behaviour (Peck & Childers 2003). Consumers with high NFT are more influenced by marketing that includes strong haptic stimuli compared to marketing with weaker haptic stimuli (Jin 2011). Accordingly, consumers with low NFT are not as affected by the presence of haptics. The ability to touch is also found to affect the price consumers are willing to pay for products. Peck and Shu (2009) found consumers to be willing to pay higher prices for products they were able to touch before purchase. A study by Kühn et al. (2020) made a similar finding as they showed consumers with high NFT to be willing to pay more for a product in a physical store compared to an online store. Positive sensory feedback from touch also increases attitudes more for people with high NFT, and thus makes them more sensitive to persuasion (Peck & Wiggins 2006).

Instrumental need for touch represents self-attributed and goal-oriented motives that drive individuals' behaviour (Peck & Childers 2003). Consumers with instrumental NFT use touch to evaluate products and their features, as well as gain comfort and certainty in their judgements (Peck & Childers 2003). Consumers with high instrumental NFT have an intention to evaluate the product's features, usefulness, and quality by touching it, and the inability to do so will cause frustration and raise concerns related to the quality of the product (Gatter et al. 2021). These consumers have a clear purchase goal, and they actively search for information before arriving to a final decision (Peck & Childers 2003).

Implicit motives, on the other hand, associate with autotelic need for touch, in which affective and compulsive themes are central (Peck & Childers 2003). Consumers with autotelic NFT do not necessarily have a purchase goal, but instead use touch for sensory stimulation and enjoyment (Peck & Childers 2003). Usually, products with a sleek design, or soft and smooth materials, appeal to people with autotelic NFT (Klatzky & Peck 2012). These qualities were presented in the previous subchapter as touch-inviting features, which explains their attraction for consumers seeking for haptic enjoyment. Autotelic NFT is based on a hedonic and compulsive need for variety-seeking through touch, and is also related to impulsive buying behaviour, as it is more spontaneous and without a clear purchase goal unlike instrumental NFT (Peck & Childers 2003). Consumers with high autotelic NFT also show stronger emotional responses to touch (Peck & Wiggins 2006), as well as stronger attachment to products (Atakan 2014). Peck and Wiggins (2006) found that including a touch element evoked an affective response for people with high autotelic NFT, increasing their persuasion. They examined this effect with a fictional charity that provided blankets for needy families. Those with high autotelic NFT showed a higher possibility of donating to the charity when there was a swatch of the blanket fabric attached to the charity pamphlet. Participants with low autotelic NFT did not show a significant difference in their attitude towards the pamphlet.

According to Gatter et al. (2021), consumers that are high in autotelic NFT are usually also higher in instrumental NFT. A study by Kühn et al. (2020) supports this, as they found consumers with high NFT to have both higher concerns about the quality, as well as lower affective responses to products in an online grocery store. The negative impacts were also found to be stronger for consumers who shopped online less than once a week, and consumers who used indirect touch interfaces, such as a keyboard and a mouse, to shop. The negative impacts were found to be lower for consumers who used direct touch interfaces, such as touchscreen devices.

According to Citrin et al. (2003), women have a higher need for haptics in product evaluations compared to men. This is supported by the findings of Workman (2010), who found women to score higher on both autotelic and instrumental dimensions. In another study by Workman and

Studak (2006), women were found to have a psychological, want-based approach to recognizing a purchasing need, which could suggest women to score higher on autotelic NFT as it is based on hedonic motives. Men, on the other hand, showed a utilitarian, need-based approach, which could be associated with goal-oriented instrumental NFT. In the context of fashion products, Workman (2010) found men to be more goal-oriented rather than seeking enjoyment, and thus scoring higher on instrumental NFT.

## 2.2 Virtual reality

### 2.2.1 Virtual environments

Wearable VR-devices such as head-mounted displays (HMDs), haptic devices, and body-tracking sensors, as well as VR environments viewed through smartphones and computer monitors, are shaping the future of online shopping by creating environments that can be accessed at anytime and anywhere (Xi & Hamari 2021; Jongsun & Jisoo 2021). Virtual reality is already being utilized in several fields of business including advertising, tourism, and product design (Xi & Hamari 2021; Orús, Ibáñez-Sánchez & Flavián 2021), as it can increase consumers' engagement and response (Cowan & Ketron 2019). VR technologies allow companies to offer advanced digital experiences, as well as practical benefits, such as unlimited opening hours in a store that is similar to a physical one (Lee et al. 2022). From retailers' perspective, VR offers opportunities to develop their e-commerce by providing online products in realistic stores with vivid presentations, enhancing the communication with customers, and enabling various entertaining features, such as virtual fashion shows (Kim, Kim, Park & Yoo 2021a). Utilizing VR and providing consumers with engaging shopping experiences is suggested to give retailers competitive edge as the reliance on digital devices for shopping is increasing (Kim et al. 2021a).

Xi and Hamari (2021) suggest a definition for VR technologies to be "technologies for substituting the perceived reality". For instance, a head-mounted display (HMD) provides stimuli that aims to affect the user psychologically and make them act as if the simulated reality is real (Xi & Hamari

2021). Gutiérrez, Vexo and Thalmann (2008) describe VR as a simulation of a realistic world that can offer both physical immersion and psychological presence (Cowan & Ketron 2019). As augmented reality (AR) creates an alternative view of reality by integrating virtual elements into the real world, virtual reality (VR) immerses the user in an artificial, digital environment (Tan, Chandukala & Reddy 2022). VR applications include product simulations, automated virtual environments, and virtual worlds (Cowan & Ketron 2019). Simulations are virtual interactions with virtual objects (Aurich, Ostermayer & Wagenknecht 2009), that enable rotating and zooming the products to evaluate them (Algharabat & Dennis 2010). Automated virtual environments are environments based on reality, that support user control and interaction with the environment (Cowan & Ketron 2019). They enable for instance, testing of product ideas or retail layouts using virtual spaces. Automated virtual environments have no visuals of the real world, and include Cave Automatic Virtual Environments (CAVE), which are based on multiple projectors and surrounding speakers, as well as HMDs, which offer less field of vision and interactivity, but can provide visual and auditory imagery based on the user's position and orientation (Meißner et al. 2019; Cowan & Ketron 2019).

Virtual worlds are computer-simulated environments that can support the interaction between users through avatars (Cowan & Ketron 2019). Virtual worlds attract consumers who seek for socialization and escape as they fulfil this need better than simulations or automated virtual environments (Vrechopoulos, Apostolou & Koutsiouris 2009; Cowan & Ketron 2019). Han, Bergs and Moorhouse (2022) have suggested that virtual worlds offer "self-indulgent escapism", which can help people to cope with stress and fast-paced lifestyle. According to Cowan and Ketron (2019), the most beneficial applications for high consumer involvement and commerce are product simulations and automated virtual environments. Table 1 presents VR technologies divided by the degree of involvement.

**Table 1.** High and low involvement VR technologies. (Cowan & Ketron 2019)

| | **Simulations** | **Automated Virtual Environments (AVEs)** | **Virtual Worlds (VWs)** |
|---|---|---|---|
| **High Involvement** | Product Display on Websites<br><br>Engagement Advertisements | CAVEs and HMDs: V-commerce | Marketer-created virtual worlds (Branded Entertainment)<br><br>Retail in SVWs |
| **Low Involvement** | Mobile Applications | CAVEs and HMDs: Pop ups | MMORGs<br><br>Product Placement<br><br>Sponsorship<br><br>Endorsers |

Media Richness Theory (MRT) by Daft and Lengel (1984) introduces four features to determine whether a communication medium is rich or poor (Moes & van Vliet 2017). These features include feedback capacity (directness and speed of reaction), used channel (text, audio or visual), focus (personal vs. impersonal media), and richness of language (written, spoken or body language). According to the theory, richer media allows users to react faster, uses multiple cues instead of one (for instance, audio and visual), and involves non-verbal communication. Moes and van Vliet (2017) present that the features of the theory can be applied to evaluate the richness of present media types, such as virtual reality. For instance, they present that a 360-degree image of a store is richer than a regular image, as the user is able to move and therefore interact with the 360-degree store. However, a VR image of the store presented through HMD is even richer, as the user only sees the store and not the display, unlike with the other two media types where the user would see for example, a laptop. According to Moes and van Vliet (2017), as VR media is the richest, it would also create the strongest shopping experience. Mishra, Shukla, Rana and Dwivedi (2021) have suggested media richness to explain their findings on consumer responses to multisensory technology (AR/VR) and mobile apps. They found consumers to have a more positive experience for hedonic products when using AR compared to a mobile app, and higher purchase intentions for utilitarian products in VR compared to the app.

### 2.2.2 Virtual shopping

Set in motion by the increase in online shopping, virtual stores have started to appear to the scene of online shopping (McDowell 2020). Brands like Charlotte Tilbury, Clarins, and Tommy Hilfiger are testing virtual store technology with stores that combine virtual reality and enhanced website elements (McDowell 2020). These virtual stores can be accessed through a desktop or a mobile device, and utilize immersive and interactive elements, which entertain consumers, but also allow purchasing of products. High-end fashion brands, such as Dolce & Gabbana, Prada, and Fendi, have opened boutiques that offer VR environments where customers can examine products through HMDs or smartphones (Jongsun & Jisoo 2021). Previous research has shown consumers to have very similar experiences in VR shopping environments as they do in physical shopping environments (Xi & Hamari 2021). Alzayat and Lee (2021) have found hedonic shopping value to increase when using a VR based retail site compared to a traditional online store. Virtual reality was found to have a positive effect on the enjoyment of the shopping experience, although the benefits were also dependent on the product category. Products that can be defined as “extensions of the body”, such as tools, were found to benefit more from the VR store experience compared to products defined as “presentations of the body”, such as clothes and accessories (Alzayat & Lee 2021). A study by Mishra et al. (2021) made a similar finding as they found hedonic products to perform better in AR experiences and utilitarian products in VR experiences. Cowan and Ketron (2019) have also expressed that product types could affect the effectiveness of virtual reality strategies. They suggest that certain product types perform better in low-involvement VR, such as mobile apps and pop-up virtual experiences, and others in high-involvement VR, such as virtual stores. According to Cowan and Ketron (2019) products that require haptic evaluation would benefit more from high-involvement VR.

Rauschnabel, Felix, and Hinsch (2019) have shown attitudes towards brands’ VR apps to depend on the experienced inspiration, which stems from the quality of the virtual content, as well as the hedonic benefits from using the app. Previous research has suggested that a notable factor affecting consumers’ hedonic experience is the playfulness of the virtual environment (Kohler, Fueller, Matzler & Stieger 2011; Gatter et al. 2021). A study by Han et al. (2020) showed perceived playfulness and perceived usefulness to have a significant effect in consumer’s VR shopping experience. These factors were also associated with consumer's behavioural intentions to visit a VR store again, as well as their purchase intentions. However, according to Kang et al. (2020), a solely playful environment serves mainly consumers who desire benefits, such as exploring luxury items, but do not necessarily have an intention to purchase. They suggest informativeness to be an important factor to incorporate in virtual shopping environments besides playfulness. According to Kang et al. (2020), visual-spatial cues are essential in making virtual shopping more informative, whereas graphics quality is found not to be as important in 3D VR environments. Rose et al. (2012) have found that the sense of control and empowerment are perceived as more important for the experience in a traditional online shopping environment, compared to the speed or graphics of the website. In VR environments, Kang et al. (2020) suggest the explanation to be the large number of other cues in addition to graphics quality, which lowers its importance when evaluating informativeness.

A rich VR shopping experience is created with effective interaction with products in a realistic, three-dimensional environment (Kim et al. 2021a). A study by Liu et al. (2019) shows that the combined effect of visual presentation and mode of interaction has a significant role in creating a realistic and consistent virtual experience. Realistic representation of a product can also increase the perceived informativeness (Kang et al. 2020), as it assists consumers to visualize the products, and thus provides utilitarian benefits by reducing the risk of dissatisfactory purchases (Gatter et al. 2021). The vividness and intensity of the interactive experience on the other hand, determines the gained hedonic benefits (Yim, Chu & Sauer 2017). Park, Choi, Kim and Kwon (2019) found interactive 3D product images to result in better attitudes, both immediate and delayed, as well as sense of presence, compared to still pictures or motion pictures of the same products. They examined the participants' delayed attitudes four weeks after the initial experiment and found that attitudes towards the products had changed the least for participants who had examined the products through 3D images. Liu et al. (2019) examined consumers' experiences using both 3D and 2D presentations, and interaction through touch screen devices and mouse-based devices. They found 3D presentations and touch screen devices to offer a more immersive experience. A similar finding has been made by Chung (2015), who found touch screen devices to lead to better engagement and enjoyment compared to devices operated with a mouse.

Virtual product visualizations and try-ons usually stem from the need of haptics (Kaushik & Gokhale 2022). Virtual product experiences aim to simulate consumers' ability to touch and feel the products through the online experience (Blazques Cano, Perry, Ashman & Waite 2017). Touch is hard to simulate in a virtual environment, which is why descriptions and images of product features, such as texture, are used to describe haptic information (Peck et al. 2013). According to Xi and Hamari (2021), communicating haptic information can also affect the amount of money consumers spend on online purchases, as well as the remembering of product names. Improving the interactivity of virtual product experiences, and thus improving how controllable and responsive consumers find the virtual presentation, is especially important in terms of achieving a substitutive experience for real product examination (Blazques Cano et al. 2017). For instance, Overmars and Poels (2015) have found that consumers who used an interactive interface to examine a product, reported a similar experience to those who had physically touched the product. Interfaces act as a method for interaction between people and media, and influence the way users obtain and process information, communicate, and experience the environment (Jongsun & Jisoo 2021). Overmars and Poels (2015) suggest that visual stimuli guide consumers to think about haptic elements and therefore results in tactile sensations. In their study both interactive and static interfaces resulted in some tactile sensations, but the effect was notably stronger with the interactive interface. They suggest that creating an active connection with products in the virtual environment is a key factor for establishing tactile sensations.

Consumers' high need for touch is likely to present a challenge for the virtual shopping experience. Alzayat and Lee (2021) have found high NFT to have a negative effect for the relationship between VR stores and the gained hedonic shopping value. In addition, Ruusunen et al. (2023) have shown autotelic NFT to negatively affect the relationship between sense of presence in a 360-virtual store and consumers' attitudes. Gatter et al. (2021) however, suggest that consumers with autotelic NFT could be more influential considering their reactions towards virtual features, and might get greater benefits from virtual experiences compared to consumers with instrumental NFT. It is assumed that consumers with instrumental NFT are more likely to perceive real touch as the only way to validly evaluate a product. In the study by Gatter et al. (2021), consumers with high NFT also rated virtual content better than those with lower NFT, which could indicate that virtual content may be able to substitute for physical experiences, at least to some extent.

### 2.2.3 Sense of presence

According to Slater and Wilbur (1997), what distinguishes immersive virtual environments is that they offer sense of presence. The concept of *presence* has received many definitions that centre around the psychological feeling of being elsewhere. Slater and Wilbur (1997) define presence as a state of consciousness, and psychological sense of being in the virtual environment. Park et al. (2019) describe presence as “experiencing a virtual environment that is distant from the actual place”. Definition by Iachini, Maffei, Masullo, Senese, Rapuano, Pascale, Sorrentino and Ruggiero (2019) states that presence is a concept to describe “the quality of subjective experience”. According to them, presence is a state of consciousness where the user of a virtual world feels and behaves as if they were actually in the world, knowing at the same time, that they are not. Berg and Vance (2017) have referred to presence as a feeling of being physically present in the virtual world.

As immersion describes the degree to which user’s mind is engaged in the virtual world instead of the real one, presence is the extent to which the virtual world replaces reality (Cowan et al. 2021). Burdea and Coiffet (2003, 2-3) suggest that presence in VR is defined by three I’s presented in Figure 2: *interactivity*, *immersion*, and *imagination*. According to this definition, *interactivity* is a key feature that enables real-time response to user’s input, and thus offers a more natural way to explore the world. *Immersion* is supported by interactivity and stands for the feeling of being part of the activities in the virtual environment. According to Burdea and Coiffet (2003, 3), immersion can be intensified by activating more of the user’s sensorial modalities. Cowan et al. (2021) also suggest that high immersion occurs when the user’s senses and mind are fully engaged. The third feature contributing to the sense of presence according to Burdea and Coiffet is *imagination,* which refers to the mind's ability to perceive things that do not exist. Loomis, Blascovich and Beall (1999) argue that the amount of sensory input in the virtual environment, ultimately determines the degree to which users can feel like they are a part of that world (Cowan & Ketron 2019). Researchers have suggested that sense of presence is affected by the ratio between information from the virtual environment and information from the physical one, and that the user can be seen as immersed when the received sensory information favours the virtual environment (Kim & Biocca 1997). Experienced sense of presence in a virtual environment is also referred to as "telepresence" (Kohler et al. 2011; Cowan & Ketron 2019).

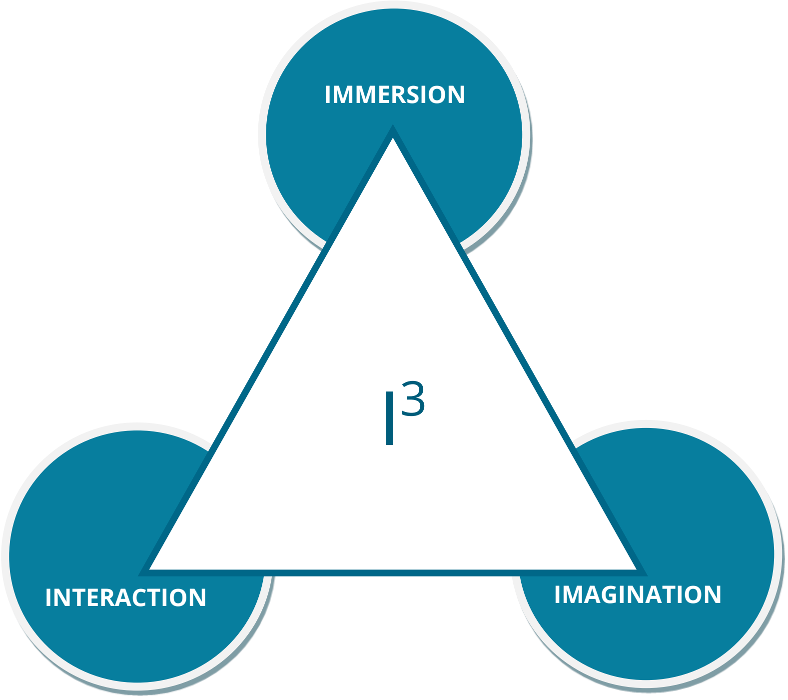


**Figure 2.** The three I's of virtual reality presence. (Burdea & Coiffet 2003, 4)

Researchers like Rice (1992) and Kim (2015) have suggested that all media types provide sense of presence, but the extent of it differs depending on the media. Verhagen et al. (2014) found experienced presence in the context of product presentation, to be highest with a virtual reality experience compared to 360-images or regular images of the products. They also found product tangibility and product likability to increase with the degree of sense of presence. Moes and van Vliet (2017) have also found medium richness to determine the degree to which consumers feel the experience to be equivalent to a physical store experience. They found that a holistic shopping experience in an online clothing store was rated more positively by consumers who experienced the store through a VR image compared to those who saw a 360-degree image of the store. A study by Bogicevic et al. (2019) further acknowledges these findings. They showed a VR preview of a hotel suite to increase users' mental imagery and sense of presence more than static computer-generated images, or 360-degree tour of the same suite. These findings suggest that an immersive virtual environment leads to stronger sense of presence. Jongsun and Jisoo (2021) however, found that in a VR environment viewed through a monitor screen, the experience of control, for example moving in the virtual store, was more important for the experienced sense of presence than visual immersion.

Interactivity (Kim et al. 2023) and vividness (Tan et al. 2022) of the VR environment are found to affect sensory brand experience, enjoyment, and attitudes towards VR, through the experienced sense of presence. Sense of presence has an important role in enhancing consumers' VR experience and attitudes (Spielmann & Mantonakis 2018; Ruusunen et al. 2023), as well as brand evaluations and purchase intention in VR environments (Cowan et al. 2021). Song et al. (2007) have suggested, that investing in technologies that improve sense of presence could help in converting "browsers to purchasers". According to Rose et al. (2012), sense of presence has a positive effect on online customer experience, as consumers can experience cognitive immersion similar to shopping in a physical store. Song et al. (2007) have found sense of presence to have a significant effect on shopping enjoyment, which further led to increased willingness to purchase. In their study, sense of presence affected willingness to purchase directly, but also indirectly through the effect of *fantasy*. Fantasy, in this context, was used to describe mental imagery that involves product usage post-purchase. The interplay between sense of presence and consumers' imagination is also shown in a study by Lee (2018). They found sensorial and emotional attributes in a hotel website to positively affect sense of presence through enabling imagined future experiences, which further affected consumers' behaviour.

According to Cowan and Ketron (2019), consumers engage with brands' VR content either with high-involvement level through imagination and sense of presence, or low-involvement level through interactivity. They argue that sense of presence results from strong engagement and processing, which is why high sense of presence rarely exists in low-involvement technologies. A strong VR presence includes enjoyment and tangibility, which enhance imagination and sense of presence, leading to more lasting attitudes and responses towards the brand. In high-involvement technology, tangibility and immersivity aim to replicate real sensory experiences, whereas in low-involvement technology, interactivity offers more superficial engagement with less sensory appeal. According to Cowan and Ketron (2019), brands' low-involvement technology is focused more on engaging consumers in a fun experience which enhances brand evaluations, rather than the purchasing of products.

As presented above, sense of presence is influenced by both technological and psychological factors (Iachini et al. 2019). Song et al. (2007) have showed virtual elements on a website to contribute to a better shopping experience through enhanced sense of presence and mental imagery. They examined this with a virtual model feature, which enabled participants to try different product combinations on the model, assisting in mentally picturing the clothes on themselves. Iachini et al. (2019) have found the ability to generate vivid imaginings to positively correlate with a high sense of presence in a computer-generated world. According to their findings, vivid imaginings, and therefore stronger sense of presence, were reported especially when the context was a common everyday setting such as a store, or a personal memory. They also found the realism of the virtual environment to affect the vividness of participants' mental imagery. The findings present the link from the vividness of the technology to the vividness of imagination, and further to the experienced sense of presence. According to Cowan and Ketron (2019), improving tangibility and immersion will enhance imagination, leading to stronger sense of presence. They suggest that in VR environments, tangibility results from gustatory and haptic factors, as these senses require the highest proximity. They present that tangibility enhances imagination by assisting in the processing of incoming sensory information.

## 2.3 Imagination

### 2.3.1 Mental imagery

Imagination is the ability to envision objects and events mentally through all senses (Pearson 2019; Ruusunen et al. 2023). According to Philips (2017), the function of imagination is to understand reality, and to augment it. While a common definition of imagery might extend it to only visual imagery, researchers have broadened the definition to include a whole physical experience with all five senses (Elder & Krishna 2022). Mental imagery results from previously obtained information combined with new sensory information, and according to Cowan et al. (2021), is especially influenced by incoming sensory cues. The process of mental imagery is similar to a real perceptual experience, however, can occur without real sensory input (Liu et al. 2019). Elder and Krishna (2022) define mental imagery by considering its sensorial nature, and the role of individual's memory in forming it. According to their definition, mental imagery is a passively or deliberately evoked multi-modal sensory and cognitive representation from memory. According to Pearson (2019), imagination stimulates all human senses with visual mental imagery being the strongest.

The human memory can be divided into sensory memory, short-term working memory, and long-term memory. Incoming sensory information is processed in the sensory memory, from where the relevant information is saved for further analysis (Hultén 2015, 143). According to Peck et al. (2013), imagining is a cognitive process where the previously attained information is represented in the working memory. This information involves for instance, feelings and sensory experiences, which allow individuals to predict the outcomes of imagined scenarios (Liu et al. 2019). Imagination is considered to consist of controlled and spontaneous imagination. Controlled imagination starts with a conscious choice and the ability to decide what to imagine, whereas uncontrolled imagination happens spontaneously and without conscious control (Philips 2017). Spontaneous imagination occurs when another mental activity is not consciously focused on and disappears when attention is redirected (Philips 2017). In controlled imagination, sensory information, which can be multisensory, is represented in the working memory

(MacInnis & Price 1987). According to Philips (2017), controlled imagination has a positive influence on choice behaviour, as information accessible in the memory is used for product evaluations and behavioural intentions.

Imagery processing affects cognitive, physiological, and behavioural aspects (MacInnis & Price 1987). Imagination's role in consumer behaviour is not a new discovery, as mental imagery has been utilized in marketing for years. Companies such as Apple and Mattel have used the phrase "imagine the possibilities" in their marketing campaigns, and Samsung's slogan for almost a decade was a simple "imagine" (Elder & Krishna 2022). Evoking consumer's imagination is found to affect both their evaluations and behaviour. According to Gatter et al. (2021), brand evaluations are affected for instance, by the emotional valence and sensory richness of consumer's imagination. Liu et al. (2019) have found the vividness of mental imagery to increase purchase intentions, and Schlosser (2003) has shown stronger mental imagery to increase consumers' attitudes. Mental imagery is also found to have a significant role in consumer behaviour (Liu et al. 2019) and brand evaluations (Li, Daugherty & Biocca 2003), when the provided sensory information is limited. Findings by Liu et al. (2019) suggest that consumer's mental imagery could provide additional information when real product interaction is not possible, and thus reduce uncertainty. According to Cowan and Ketron (2019), enhancing the stimulation of consumer's imagination also leads to increased sense of presence in virtual environments.

Imagination is not an individual construct, but instead a multifaceted concept that according to Zabelina and Condon (2019), is measurable when it is divided into separate factors. Imagery is currently measured with self-reported measures, neuroscience measures, such as brain activation, and by examining human behaviour (Elder & Krishna 2022). Some self-reported measures for measuring individual's imagination include Zabelina and Condon's (2019) Four-Factor Imagination Scale, and the Plymouth Sensory Imagery Questionnaire by Andrade, May, Deeprose, Baugh and Ganis (2014). The Four-Factor Imagination Scale focuses on individual differences in parts of the imaginative process, which include frequency, complexity, emotional valence, and directedness of imagination. In this scale, frequency refers to the time spent in an imaginative state, complexity stands for the amount of detail in imagination, emotional valence is the extent to which imaginings are mostly positive or negative, and directedness of imagination represents how goal-oriented the imaginings are (Zabelina & Condon 2019). The Plymouth Sensory Imagery Questionnaire measures the vividness of imagery across the sensory modalities of vision, sound, smell, taste, touch, bodily sensation, and emotional feeling (Andrade et al. 2014). The questionnaire consists of five items for each of the sensory modalities, which instruct the participant to imagine different sensorial items. Andrade et al. (2014) suggest the questionnaire to be applicable to measure the vividness of imagination in areas of cognitive, neuroscientific, clinical, and imagery research. According to Iachini et al. (2019), the vividness of mental imagery can be considered an important factor in presenting individual differences in the ability to imagine. However, according to Zabelina and Condon (2019), imagination comprises features beyond vividness.

### 2.3.2 Haptic imagery

Mental imagery can be divided into sensory dimensions such as gustatory imagery, olfactory imagery, haptic imagery, and spatial imagery (Liu et al. 2019). These dimensions are triggered by different stimuli and through different mechanisms (Kosslyn, Thompson & Ganis 2006; ref. Liu et al. 2019). Sensory imagery is a sensory experience that originates from activating another human sense (Elder & Krishna 2010). The mental imagery of touching an item and imagining its haptic features is referred to as “touch simulation” (Lee & Choi 2021). The mental simulation of touch can happen unintentionally, and it is triggered by a representation of the item, for instance a picture (Petit et al. 2019; Lee et al. 2022). Mental simulation activates the same regions of the brain as the actual physical experience and is based on previous experiences where the brain has extracted sensory cues related to that specific item. Exposure to a picture of the item activates a simulation of those previous perceptions. In the haptic imagery process, previously obtained sensory information is retrieved in the working memory and can generate similar sensations as the initial experience (Barsalou 2008; Peck et al. 2013; Gatter et al. 2021; Hamacher & Buchkremer 2022). According to Peck et al. (2013), if the object is already familiar to the person, haptic imagery may be more vivid due to past experiences, whereas with unfamiliar objects haptic imagery might not be as influential. Klatzky, Lederman and Matula (1993) have introduced a “visual preview model”, which suggests that a preliminary visual analysis of an object’s haptic properties is used together with the retrieval of past experiences, to reach a purchase decision. According to this theory, if the visually obtained information of the product’s properties, together with the retrieved information, is sufficient, actual touch is not needed. This theory would thus imply that consumer’s haptic imagery, based on previously attained information from the memory, assists in the purchase decision when physical examination is not possible. However, according to Klatzky et al. (1993), if the visual representation is not informative enough, extraction of haptic information might be needed to reach the decision.

Previous research has provided evidence to support that visual presentation could facilitate mental simulation of sensory experiences, with further effects on consumers’ behaviour (Elder & Krishna 2012; Liu et al. 2019; Lee & Choi 2021). Elder and Krishna (2012) found the visual depiction of products in advertisements to determine the degree to which the participants experienced mental simulation of holding and using the product. Greater mental simulation was also found to have a significant positive effect on the participants’ purchase intentions. The effect found in their study is presented in Figure 3. A study by Kim, Kim, Park and Yoo (2021b) showed a significant correlation between sensory perceptions and mental imagery for participants shopping for clothing items in an in-store setting. From all five senses, visual and haptic perceptions were found to be significant in the context of clothing items. They found mental imagery and sensory perceptions to have an indirect effect on behavioural intentions through anticipatory emotion and decision confidence. However, sensory perceptions had a stronger influence on consumer responses compared to mental imagery. The findings demonstrate the role of sensory perceptions and mental imagery for consumers’ decision-making and the challenge that arises from limited sensory perceptions. Kim et al. (2021b) argue that product presentations should not only invite physical interaction but to aim at activating consumers’ mental imagery. They suggest that the use of visual content could assist in evoking mental consumption images.

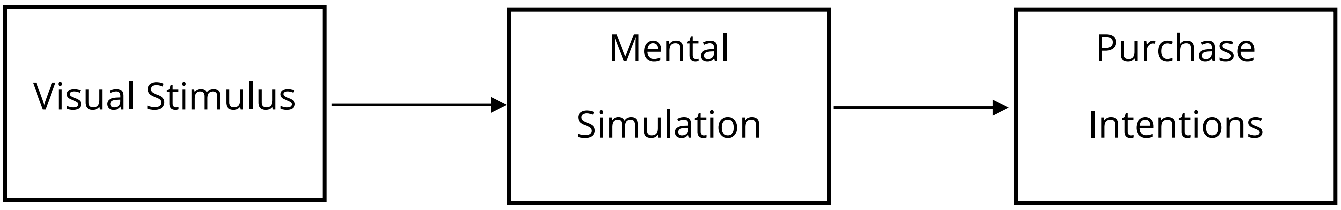


**Figure 3.** The effect of visual stimuli to mental simulation. (Elder & Krishna 2012)

Research on the connections between imagery and perception has shed light on the possibilities to affect consumer's perceptions and sensory experiences through imagination. Imagination and perception use the same psychological processes, although imagination originates from internal sources, whereas perceptions are derived from external stimuli (Philips 2017). Imagination produces an understanding of perceived stimuli and therefore constructs reality, but it is also able to create content and realistic scenarios that are separate from reality (Philips 2017). Research by Yoo, Freeman, McCarthy and Jolesz (2003) showed haptic imagery to share same neural circuitries used in perception of real haptic stimulation. The neural substrates of mental imagery of touch were examined with functional MRI, which suggested at least a partial overlap in neural networks. This would imply that the processes of imagery and perception influence each other (Anema, de Haan, Gebuis & Dijkerman 2012). Anema et al. (2012) found haptic imagery to result in a fast response to haptic stimuli, which would support the connection between haptic imagery and haptic perception. They found that when participants imagined a haptic sensation, for example a hand full of gravel, their somatosensory system was activated, resulting in a perception of haptic stimuli. A study by Peck et al. (2013) has found haptic imagery to produce a similar feeling of ownership as physical touch. Their study showed haptic imagery to affect participants' perceptions of physical control, which led to feelings of ownership and increased perception of the object's value. This effect was further amplified by the vividness of participants' haptic imagery.

According to Peck and Childers (2003), individuals with higher NFT have a greater accessibility to haptic information in their memory. For these individuals, haptic information is more chronically accessible, and they can easily retrieve this information from their memory. Peck et al. (2013)

also suggest that individuals with high NFT may form haptic imagery spontaneously to compensate for the lack of touch, and actually end up being disappointed with the product when they eventually get the opportunity to touch it. A study by Gatter et al. (2021) suggests that consumers with high autotelic NFT are more likely to utilize haptic imagery when engaging with virtual technology compared to consumers with lower NFT. They further imply that the imagined experiences, as well as the gained hedonic benefits, are stronger and more associated with real haptic experiences. A study by Ruusunen et al. (2023) showed imagination to assist in compensating for instrumental NFT, but not autotelic NFT, in a 360-virtual store. They conclude that compensating for the hedonic benefits of touch with visual information might be more challenging compared to utilitarian benefits. It is further suggested that it could be easier to imagine, and recall from memory, the utilitarian features such as size and shape, than the hedonic qualities, such as feelings of sensory pleasure (Ruusunen et al. 2023). In addition, according to Peck et al. (2013), attributes like softness, could be easier to imagine than properties such as the weight of a product. Lee et al. (2022) however, have showed touch simulation to increase the experienced pleasure during VR shopping for consumers with high autotelic NFT.

### 2.3.3 Haptic imagery in virtual environments

Stimulating imaginations is largely affected by tangibility and immersivity (Cowan & Ketron 2019). Immersion in the context of virtual environments refers to the extent to which the technology is able to create an inclusive and vivid environment that responds to the human senses (Slater & Wilbur 1997). Tangibility on the other hand, refers to the physical presence of products or experiences, and their accessibility to the senses, as well as their mental comprehensibility (Laroche, Yang, McDougall & Bergeron 2005). As stated earlier, imagination requires previous experiences and knowledge, as well as incoming sensory information. According to Cowan and Ketron (2019), incoming information is easier to process, and therefore stimulates the imagination more, when it's tangible. Lack of mental tangibility prevents consumers from imagining the different elements of a product sensation, for instance how the product feels (Kaushik & Gokhale 2022), which is why tangibility is an important factor in creating virtual consumer experiences. Increasing the use of sensory cues in virtual environments is suggested to feed consumers' imagination and promote information processing through increased tangibility (Cowan & Ketron 2019).

Consumers' imagery through vicarious consumption has been suggested by MacInnis and Price (1987) to contribute to positive sensory and emotional experiences. According to Argyriou (2014), vivid mental imagery could be stimulated for instance, with vivid animation features. Sagha, Seyyedamiri, Foroudi and Akbari (2022) have examined the effect of mental imagery of scents on consumer responses. They stimulated olfactory imagery with dynamic and static visual content, and found dynamic animation related to the scent of coffee to affect olfactory imagery more than a static image related to the product. Greater sensory imagery was found to lead to significantly enhanced emotions, experiences, and willingness to purchase. Accordingly, dynamic visual content could contribute to stimulating haptic imagery as well. A study by Lee et al. (2022) showed realistic product demonstrations in a virtual environment to increase the vividness of the imagined product experiences. The same effect was found in a study by Liu et al. (2019). A more realistic 3D presentation of a product enabled consumers to receive visual feedback in real-time by observing the product from multiple angles, leading to more vivid haptic imagery compared to a 2D presentation. According to Schlosser (2003), interactivity with products in virtual stores also assists in imagining the usage of a product. Imagination could thus have an important role in environments where consumers are unable to touch or try on the products (Cowan & Dai 2014).

Several studies have shown content with vicarious touch to promote haptic imagery and lead to positive behavioural intentions.  A study by Pino, Amatulli, Nataraajan, De Angelis, Peluso and Guido (2020) showed that seeing another person touching a product generated a "mirror-touch" effect, which led to mental simulation of haptic sensations. Participants who saw a picture with vicarious touch were able to visualize themselves touching the product better, than participants who saw a picture without vicarious touch. It was also found that the imagined product touch increased the expected ease of use of the products. Another study by Kühn et al. (2020) also demonstrated the benefits of stimulating haptic imagery through the use of touch surrogates.

They showed videos of haptic evaluation by vicarious touch to reduce the negative impacts of consumers’ high NFT in online stores. A recent study by Jiang, Luo and Zheng (2024) lends further support for the previous findings. They showed a sensory-rich tactile compensation video to enhance participants’ mental imagery and the perception of sensory similarity, leading to improved decisions-making and purchase intentions. They used a tactile compensation video with a model wearing a clothing item and demonstrating its tactile sensations. They also disclosed that retailers’ efforts at providing innovative solutions are acknowledged by consumers and contribute to more positive behavioural intentions, as well as positive evaluations. Including touch simulation in virtual environments could thus improve the sensory experience through sensory imagery.

Previous research has also provided evidence that haptic imagery in virtual environments could be dependent on the type of device used in viewing the products. Touch screen devices have been found to create stronger haptic imagery compared to interaction through a non-touch device, such as a laptop with a mouse (Liu et al. 2019; Lee & Choi 2021). Hand motion while touching an image of a product is found to lead to a feeling of actual touch and produce imaginings of the haptic features (Liu et al. 2019). The effect of seemingly touching the product results from previous perceptions that are activated when the product is touched through a touch screen device (Lee & Choi 2021). This effect was found to be stronger for people with high autotelic NFT. As stated earlier, consumers with high NFT are suggested to access memories of haptic information easier, and thus mentally simulate those previous experiences when touching an image of a certain fabric (Lee & Choi 2021). This effect did not apply to people with high instrumental NFT, as they tend to use touch to assist with their decision-making, and a touch screen device does not provide the desired information. For people with high instrumental NFT the degree of mental simulation was found to be the same regardless of the device (Lee & Choi 2021). Psychological presence and ease of imagining are even higher when high embodied devices, such as HMDs are used, compared to devices with less embodiment (Orús et al. 2021).

The theoretical framework of this thesis is based on a review of previous research on the examined topic. The key findings of previous research are presented in Table 2.

**Table 2.** Key findings of previous research.

| Author/authors | Title | Topic | Findings |
|---|---|---|---|
| Alzayat & Lee (2021) | Virtual products as an extension of my body: exploring hedonic and utilitarian shopping value in a virtual reality retail environment. Journal of Business Research 130, 348-363. | Virtual shopping and high NFT | VR based retail site increases hedonic shopping value compared to a traditional online store. High NFT however, has a negative effect on the experience. |
| Bogicevic, Seo, Kandampully, Liu & Rudd (2019) | Virtual reality presence as a preamble of tourism experience: the role of mental imagery. Tourism Management 74, 55-64. | Sense of presence and mental imagery | A VR preview of a hotel suite increases mental imagery and sense of presence more than static images or 360-tour of the suite. |
| Cowan & Ketron (2019) | A dual model of product involvement for effective virtual reality: the roles of imagination, co-creation, telepresence, and interactivity. Journal of Business Research 100, 483-492. | Virtual environments and imagination | Vivid visual stimuli and the use of sensory cues activate consumer's imagination. Improving tangibility and immersion enhances imagination and leads to stronger sense of presence. |
| Elder & Krishna (2012) | The "visual depiction effect" in advertising: facilitating embodied mental simulation through product orientation. The Journal of Consumer Research 38 (6), 988-1003. | Mental simulation | Visual representation of an object can provide mental simulation of holding and using the product, leading to similar behavioural outcomes as physical interaction. |
| Gatter, Hüttl-Maack & Rauschnabel (2021) | Can augmented reality satisfy consumers' need for touch? Psychology & marketing 39 (3), 508-523. | Virtual product presentations and NFT | Realistic product presentations assist in visualizing the products and thus, reduce the perceived risk. Consumers with high NFT rate virtual content better than those with lower NFT. |
| Iachini, Maffei, Masullo, Senese, Rapuano, Pascale, Sorrentino & Ruggiero (2019) | The experience of virtual reality: are individual differences in mental imagery associated with sense of presence? Cognitive Processing 20 (3), 291-298. | Sense of presence and mental imagery | Ability to generate vivid imaginings positively correlates with high sense of presence in the context of a computer-generated environment. |
| Kaushik & Gokhale (2022) | Online sensory marketing: developing five-dimensional multi-sensory brand experiences and its effectiveness. Cardiometry 11 (24), 567-576 | Haptic imagery and tangibility | Online product interactions are mainly related to mental images and perceptions due to limited sensory information. When real touch is not possible, imagined touch is an essential factor in increasing the perception of tangibility. |

| | | | |
|---|---|---|---|
| Klatzky, Lederman & Matula (1993) | Haptic exploration in the presence of vision. Journal of Experimental Psychology: Human perception and performance 19 (4), 726-743. | Visual preview model | Visually obtained information of haptic properties is used together with retrieved past experiences to reach a purchase decision when physical examination is not possible. If this information is sufficient, real touch is not needed. |
| Kühn, Lichters & Krey (2020) | The touchy issue of produce: need for touch in online grocery retailing. Journal of Business Research 117, 244-255. | Online shopping and high NFT | Consumers with high NFT are willing to pay more for products in physical stores and have higher concerns about the quality of online products. Content with vicarious touch can reduce this negative effect. |
| Lee, Yoon & Choi (2022) | The effect of touch simulation in virtual reality shopping. Fashion and Textiles 9 (1), 1-22. | Virtual product presentations and haptic imagery | Realistic product presentations in a virtual environment increase the vividness of imagined product use. For consumers with high autotelic NFT, a touch simulation enhances the VR experience. |
| Liu, Jiang & Chan (2019) | Touching products virtually: facilitating consumer mental imagery with gesture control and visual presentation. Journal of Management Information Systems 36 (3), 823-854. | Virtual product presentations and haptic imagery | 3D product presentations and interaction through touch screen devices offer more immersive virtual experience than 2D presentations or mouse-based devices. Realistic presentations lead to more vivid haptic imagery and enhanced consumer behaviour. |
| Overmars & Poels (2015) | Online product experiences: the effect of simulating stroking gestures on product understanding and the critical role of user control. Computers in Human Behavior 51, 272.-284. | Virtual product presentations and haptic imagery | Visual stimuli produce imagery of haptic elements and result in tactile sensations. The effect is intensified when using interactive interfaces, such as touch screen devices. |
| Park, Choi, Kim & Kwon (2019) | The influence of media type and length of time delay on user attitude: effects of product-focused virtual reality. Computers in Human Behavior 101, 466- 473. | Virtual product presentations | Interactive, 3D product presentations result in better attitudes and sense of presence compared to still or motion pictures. |
| Peck & Childers (2003) | Individual differences in haptic information processing: the “need for touch” scale. The Journal of consumer research 30 (3), 430-442. | Need for touch | Consumers preference to obtain haptic information varies depending on the degree of NFT, and the dimension of hedonic autotelic NFT or goal-oriented instrumental NFT. |

| | | | |
|---|---|---|---|
| Peck, Barger & Webb (2013) | In search of a surrogate for touch: the effect of haptic imagery on perceived ownership. Journal of consumer psychology 23 (2), 189-196. | Haptic imagery | Vivid haptic imagery produces a similar feeling of ownership as physical touch through the perception of physical control. |
| Petit, Velasco & Spence (2019) | Digital sensory marketing: integrating new technologies into multisensory online experience. Journal of interactive marketing 45, 42-61. | Virtual product presentations and mental imagery | Vivid visual presentation activates past experiences and leads to imaginings of product use and sensorial features. |
| Ruusunen, Hallikainen & Laukkanen (2023) | Does imagination compensate for the need for touch in 360-virtual shopping? International journal of information management 70, 102622. | Virtual shopping and imagination | Autotelic NFT has a negative effect for sense of presence and consumer attitudes in a 360-virtual store. Imagination can compensate for the effect of instrumental NFT, but not autotelic NFT. |
| Sagha, Seyyedamiri, Foroudi & Akbari (2022) | The one thing you need to change is emotions: the effect of multi-sensory marketing on consumer behavior. Sustainability 14 (4), 2334. | Virtual product presentations and sensory imagery | Dynamic visual content increases sensory imagery, leading to enhanced emotions, experiences, and willingness to purchase. |
| Song, Fiore & Park (2007) | Telepresence and fantasy in online apparel shopping experience. Journal of Fashion Marketing and Management 11 (4), 553-570. | Sense of presence and mental imagery | Sense of presence significantly influences online shopping enjoyment and willingness to purchase, both directly and through mental imagery. |
| Verhagen, Vonkeman, Feldberg & Verhagen (2014) | Present it like it is here: creating local presence to improve online product experiences. Computers in Human Behavior 39, 270- 280. | Sense of presence | Experienced sense of presence is highest in a VR experience compared to 360-images or regular images. |
| Yoo, Freeman, McCarthy & Jolesz (2003) | Neural substrates of tactile imagery: a functional MRI study. Neuroreport 14 (4), 581-585. | Haptic imagery | Haptic imagery shares same neural circuitries as perception of real haptic stimuli. |

## 2.4 Research model and hypotheses

The hypotheses of this study are derived from the theoretical background presented in the literature review. This subchapter presents the research model and hypotheses in Figure 4, as well as brief introductions to each hypothesis.

The definition by Burdea and Coiffet (2003) specifies imagination as one of the three elements to contribute to the sense of presence in virtual reality. Imagined sensory experience is found to activate the same regions of the brain as an actual sensory experience, leading to a very similar sensation (Barsalou 2008; Yoo et al. 2003; Anema et al. 2012; Peck et al. 2013; Gatter et al. 2021; Hamacher & Buchkremer 2022). Accordingly, vivid haptic imagery affects the experienced sensory similarity and tangibility of the experience (Elder & Krishna 2012; Liu et al. 2019; Lee et al. 2022; Jiang et al. 2024). Enhanced tangibility, as well as higher immersion from engaging the human senses, are found to contribute to increased sense of presence (Cowan & Ketron 2019; Cowan et al. 2021). Based on this theory, and the findings from previous research which have suggested enhanced imaginings leading to enhanced sense of presence (Song et al. 2007; Lee 2018; Cowan & Ketron 2019; Bogicevic et al. 2019; Iachini et al. 2019), it can be hypothesized that:

*H1 Haptic imagery strengthens sense of presence in a virtual environment.*

High NFT is found to have a significant negative effect for online shopping, especially in product categories that usually require haptic evaluation (Citrin et al. 2003; Kühn et al. 2020). Consumers with high NFT are more confident in their choices when they can physically examine the products, whereas consumers with low NFT can base their decision on visual examination (Peck & Childers 2003). Inability to physically examine the products causes frustration, concerns about the quality, and lower affective responses for consumers with high NFT (Kühn et al. 2020; Gatter et al. 2021). These consumers are also willing to pay higher prices for products in stores where physical examination is possible (Peck & Shu 2009; Kühn et al. 2020). Previous research has found high NFT to have a negative effect on the relationships between VR stores and gained hedonic shopping value (Alzayat & Lee 2021), as well as sense of presence and consumer's attitude (Ruusunen et al. 2023). Consumers with high NFT require strong haptic stimuli (Jin 2011), and although sense of presence in a virtual store is found to generate a similar immersive experience to a physical one (Rose et al. 2012), it does not provide real haptic information. Therefore, the second hypothesis is:

*H2 Greater a) autotelic and b) instrumental need for touch (NFT) weakens the relationship between haptic imagery and sense of presence.*

Imagination is referred to as the ability to envision objects and events mentally through the senses (Pearson 2019; Ruusunen et al. 2023). Imagination can create realistic content and scenarios separate from reality (Philips 2017) and provide additional information when real interaction is not possible (Liu et al. 2019). Greater sensory imagery leads to enhanced emotions and experiences (Sagha et al. 2022) through the generation of similar sensations to real experiences (Barsalou 2008; Peck et al. 2013; Gatter et al. 2021; Hamacher & Buchkremer 2022). Individuals with higher NFT have a greater accessibility to haptic information in their memory (Peck & Childers 2003) and might form imagery spontaneously to compensate for the lack of touch (Peck et al. 2013). Imagination is also found in previous research to assist in compensating for instrumental NFT in a virtual store (Ruusunen et al. 2023). Therefore, the third hypothesis is:

*H3 Imagination moderates the negative effect of a) autotelic and b) instrumental need for touch (NFT) on the relationship between haptic imagery and sense of presence.*

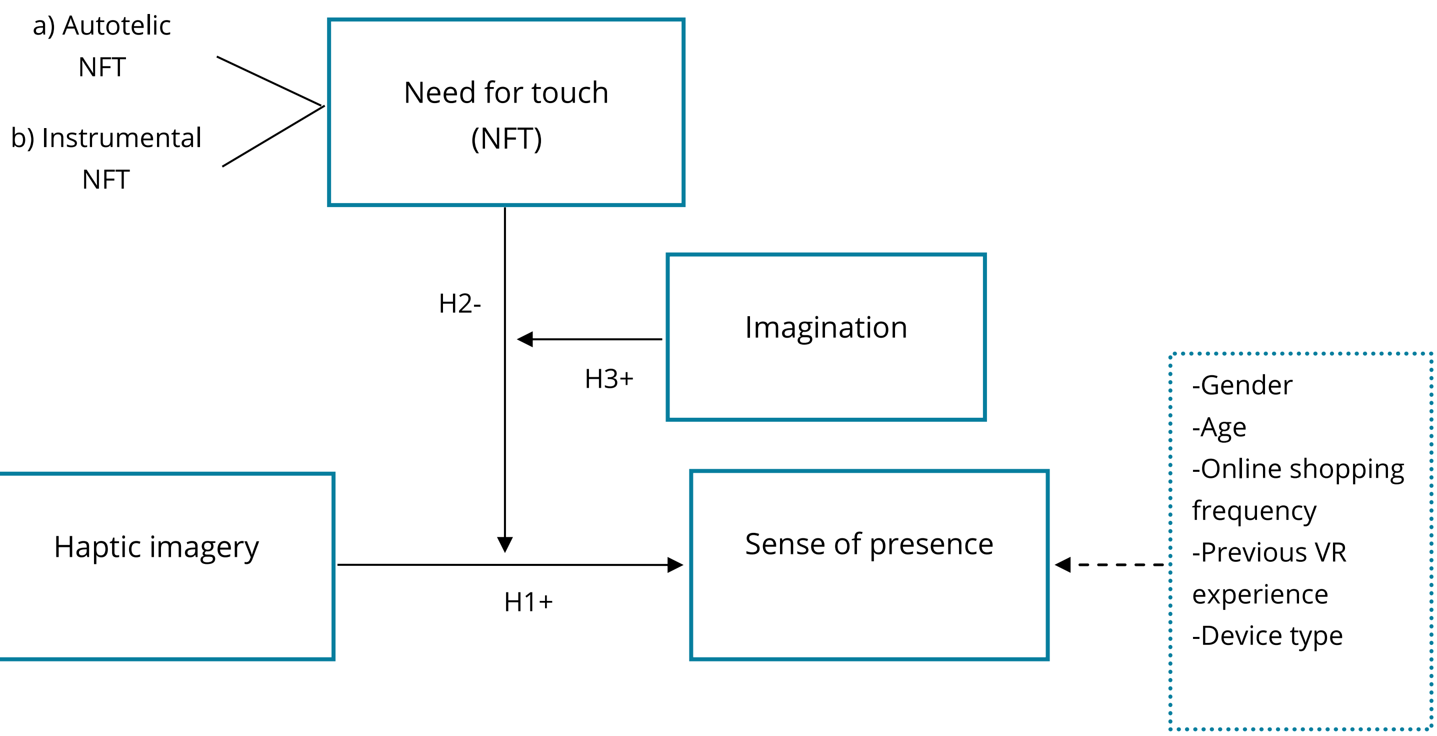


**Figure 4.** Research model.

# 3 Research

## 3.1 Research method

### 3.1.1 Quantitative research method

The aim of this study is to examine whether the lack of touch in virtual environments can be compensated with consumers' imagination. A quantitative research method was chosen to conduct the study, as it examines relationships between variables (Punch 2003, 3), and is extensively used in previous research on similar concepts. Quantitative research, also referred to as statistical research, aims to answer questions "what?", "where?", "how often?" and "how much?" (Nummenmaa, Holopainen & Pulkkinen 2019, 16). It is often used to examine correlations between factors, and changes occurring in the examined phenomenon (Heikkilä 2014, 15). Statistical research examines numerical data and makes generalizations based on observations (Heikkilä 2014, 15), as well as discovers random factors in the phenomenon (Metsämuuronen 2011, 35). Statistical research gathers new information systematically and complements existing information on the subject (Nummenmaa et al. 2019, 12). With statistical methods, the gathered data can be condensed into a more understandable form, and therefore the most relevant information is brought out (Nummenmaa et al. 2019, 10).

The research data is collected with an online survey. A survey questionnaire is a data collection tool that is guided by the chosen research questions (Punch 2003, 30). The most common survey method for data collection is a self-administered, self-report questionnaire (Punch 2003, 41). The reliability of survey data stands for the stability of responses (Punch 2003, 42), which means that the reliability of the data can be considered high if the respondents would answer the same way, were the survey questions asked again. The validity of survey data represents whether the responses measure the variables they are supposed to measure (Punch 2003, 42). The construction of the survey questionnaire is presented in the next subchapter.

### 3.1.2 Survey questionnaire

The survey questionnaire for the data collection consists of measures for the concepts of *sense of presence*, *haptic imagery*, *need for touch (NFT)*, and *imagination*. The survey was constructed using measurement scales introduced in previous research and proven to perform successfully in measuring the concepts. Existing measurement scales are usually reliable as they have likely been tested on a vast number of people, and the scale's reliability has been examined and described (Metsämuuronen 2011, 67). Using existing measurement scales is also advisable for researchers with less measurement expertise, as the attempt to construct measures with major variables and multiple items without previous experience and required knowledge, can affect the quality of the results (Punch 2003, 32). According to Metsämuuronen (2011, 67), the results obtained with existing measurement scales are also largely comparable with results from other studies using the same scales. A successful survey questionnaire is usually a combination of existing, and occasionally modified, instruments (Punch 2003, 32).

The measurement scales chosen for this study use self-reported measures for the concepts. The scales include Likert scales, and a scale ranging from -3 to +3. A Likert scale is an interval scale, which enables the gathering of information on the differences between the values of the variables (Metsämuuronen 2011, 70). In this study, the scale is used to measure the participants' individual scores in the examined concepts. Likert scale is specifically used to measure attitude, motivation, and other self-reported judgments of the participant, and it usually follows either a 5-point scale or a 7-point scale (Metsämuuronen 2011, 70). The chosen control variable items are measured with multiple choice questions, except for the variable of age, which is an open-ended question. The measurement scales used in the survey are presented in Table 3.

In this survey, sense of presence is measured using a questionnaire adapted from Kim and Biocca (1997), with 7 items measured on a 7-point Likert scale. The phrasing of the questionnaire items was modified to fit the context of virtual stores. From the original 8 items, one was excluded as the item statement is essentially the same with another item on the scale. The purpose for this is to keep the survey concise and clear for the participants. The same item has been excluded from the scale in multiple previous research (Bogicevic et al. 2019; Park et al.

2019; Han et al. 2020) without it affecting the scale's performance, which supported the decision to do so in this survey too. The questionnaire measures sense of presence with items such as "During the visit, I felt I was in the world of the virtual store" and "The virtual store seemed to me like somewhere I visited rather than something I saw".

Haptic imagery is measured with the vividness of haptic imagery scale by Peck et al. (2013). The three items in the original scale measure haptic imagery in terms of a specific object. Therefore, the phrasing of the scale's items was modified to the contexts of this study. The items measure the vividness of haptic imagery during the virtual store visit with statements such as "I felt that I could examine the textures of the products in the virtual store", using a 7-point Likert scale ranging from "strongly disagree" to "strongly agree".

Need for touch (NFT) is measured with a scale developed by Peck and Childers (2003), with 12 items divided into 6 autotelic NFT items and 6 instrumental NFT items. The questionnaire measures the hedonic-oriented autotelic NFT with items such as "When walking through stores, I can't help touching all kinds of products", and the goal-oriented instrumental NFT with items such as "I place more trust in products that can be touched before purchase". The measurement scale for NFT ranges from -3 to +3.

Lastly, imagination is measured with a scale adapted from the Plymouth sensory imagery questionnaire by Andrade et al. (2014), measured on a 7-point Likert scale. The complete questionnaire measures seven factors including all five senses, bodily sensation, and emotional feeling. As this study is focused on the imagined sense of touch, only the items measuring imaginings of touch were chosen for the survey. The questionnaire instructs the participant to imagine touching different items including warm sand and icy water, and to then evaluate the vividness of the imaginings. The complete survey included 37 question items in addition to the control variable items. From these question items, 27 were used in this study, and can be found in Appendix 1.

**Table 3.** Measurement scales used in the survey.

| Concept | | Measurement scale | Source |
|---|---|---|---|
| Control variables | Gender | Multiple choice | |
| | Age | Open-ended | |
| | Online shopping frequency | Multiple choice | |
| | Previous VR store experience | Multiple choice | |
| | Device type | Multiple choice | |
| Sense of presence | | 7-point Likert scale | Kim & Biocca (1997) |
| Vividness of haptic imagery | | 7-point Likert scale | Peck et al. (2013) |
| Need for touch (NFT) | | Scale from -3 to +3 | Peck & Childers (2003) |
| Imagination | | 7-point Likert scale | Andrade et al. (2014) |

The control variables chosen for this study include participants' background information and other variables that might affect the examined concepts. Device type was chosen as it has been found in previous research to affect consumers' imagery and behaviour. Touch screen devices have been found to create stronger haptic imagery compared to non-touch devices, such as laptops used with a mouse (Liu et al. 2019; Lee & Choi 2021). Device type has also been found to affect the experienced immersiveness and engagement of virtual environments (Chung 2015; Liu et al. 2019). Touch screen devices were found to perform better in terms of virtual environment experience, compared to mouse-based devices. Brasel and Gips (2013) found touch screen devices to create stronger psychological ownership of products with haptic importance, compared to touchpads or mouse-based devices. Therefore, they suggest future researchers to record the used interface when conducting computer-based research. Based on these findings, the device type used in the experiment was chosen as a control variable for this study. Other control variables include background information of gender, age, online shopping frequency, and previous experience on virtual reality stores.

### 3.1.3 Bloomingdale's VR store

This study uses a virtual store by American department store Bloomingdale's[1]. The store is developed by a virtual experience company Emperia, and it was launched in November 2022 for the holiday season. The store consists of unique spaces representing departments for holiday-related products, such as fragrances, festive outfits, and stocking stuffers. The spaces do not mimic traditional store departments but are instead a variety of computer-generated environments. The spaces include for instance, a mountain lodge, a spa, a giant chessboard, and the moon. Users can move around the departments by clicking the floor, or with the arrow keys on their keyboard. Looking around is performed by clicking and turning the field of view. Transferring between the departments happens with an "elevator" through a drop-down menu on the site. Examples of the departments in the virtual store are presented in Figures 5 and 6.

**Figure 5.** A party-themed department in the virtual store.

[1] https://www.bloomingdales.com/c/anniversary/metaverse-shopping/

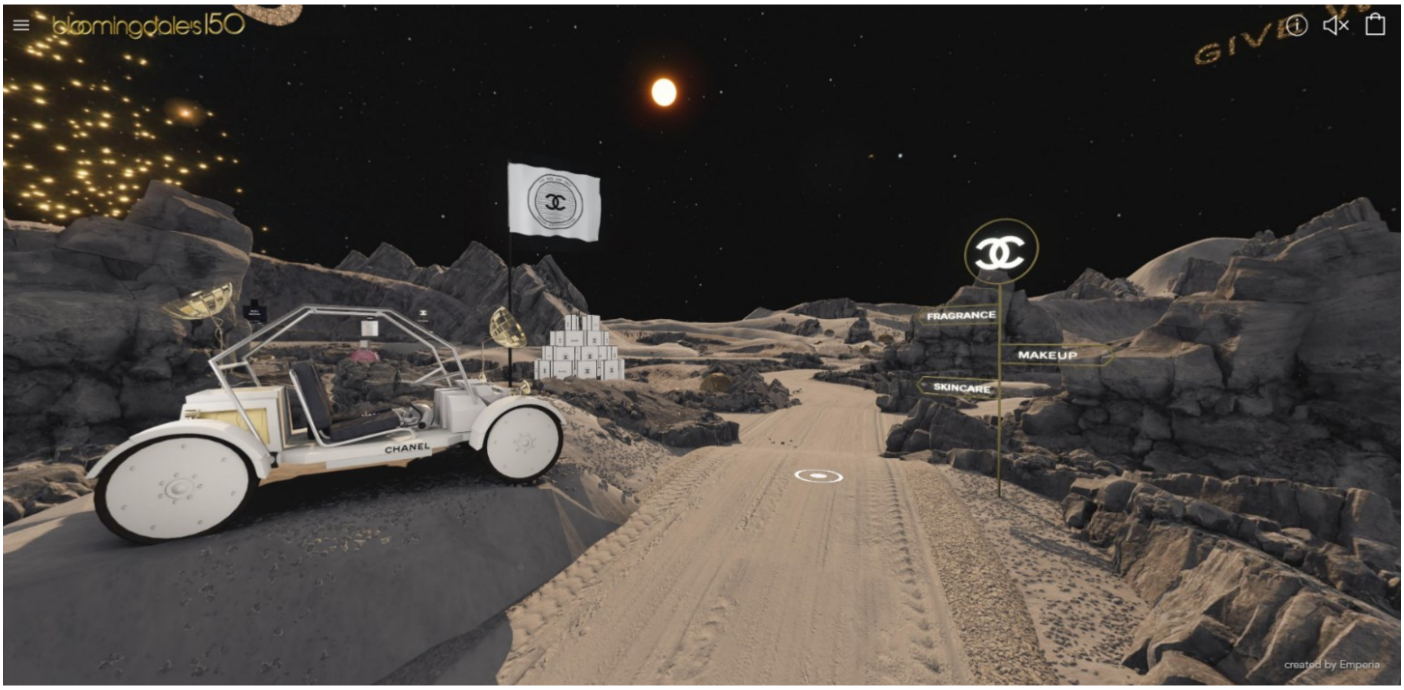


**Figure 6.** Luxury brand Chanel's department in the virtual store.

The products in the Bloomingdale's virtual store are presented in three-dimensional form around the departments. By clicking the products, the user can open a window with more product pictures and information, as well as the ability to purchase the item. The virtual store enables zooming the products in the department to get a closer look but does not allow rotating the three-dimensional products. Some of the clothing items and other fabric-made products include more detailed pictures of the material of the product, however, this does not apply to all the products. Some of the products are also occasionally updated to new products similarly to a traditional online store. An example of the product presentations in the virtual store is shown in Figure 7.

**Figure 7.** Products on display in the virtual store.

The Bloomingdale's virtual store is one of the first multi-brand virtual experiences consisting of their own holiday-themed spaces, as well as spaces dedicated for brands to communicate their brand stories (Emperia 2022). According to Emperia (2022), virtual e-commerce stores are becoming an essential factor in shopping, and the multi-brand Bloomingdale's store acts as a pioneer of the future of online shopping, and the possibilities of metaverse. The holiday store is a continuation for their previous virtual store experiment earlier in 2022, which was developed to celebrate Bloomingdale's 150-year anniversary.

## 3.2 Data collection

The data for this study was collected with an online survey. The survey was constructed with Webropol survey and reporting platform and consisted of mandatory questions measuring the concepts of this study. Prior to filling out the survey, participants were directed to visit the Bloomingdale's virtual store. Based on the visit, participants answered the questionnaire items of sense of presence and haptic imagery, followed with the self-reported items of need for touch and imagination. Background information of gender and age were filled at the beginning of the survey, and the items regarding previous experience on VR stores, online shopping frequency, and the device type used to visit the Bloomingdale's virtual store, were filled at the end of the survey.

According to Punch (2003, 38), deliberate or purposive sampling is best fitted for studies that examine the relationship between variables. Purposive sampling maximizes the independent variable variance, whereas random sampling is more generalizable and aims at representing the distribution of the examined phenomenon (Punch 2003, 38-39). As the main focus in this study is to examine the relationships between imagination, need for touch, and sense of presence, and whether imagination can compensate for the lack of haptics in the context of virtual environments, a purposive sampling strategy was chosen. The selected sample consists of basic degree students attending the University of Eastern Finland (UEF). The survey was conducted in English in order to reach non-Finnish speaking students as well. Using the original language of the chosen measurement scales also eliminates any possible problems, that according to Punch (2003, 32) could be involved in translated survey questions.

The survey link was sent via email to 5000 basic degree students who were registered as being present at the university during the time of the data collection. An equal number of students were included from all faculties of the University of Eastern Finland (UEF), and a chance to win a small prize was included to encourage participation, as the response rate in the chosen target group is often found to be low. Participants were given instructions to locate a certain clothing product from one department in the Bloomingdale's virtual store and to report the price of that product to ensure an adequate visit to the virtual store prior to filling out the survey. Participants were also encouraged to explore other departments and products inside the store.

The survey invitation was sent on the 19th of February 2024, and the survey link was open for three weeks until the 11th of March 2024. During this time, two reminder emails were sent, after approximately a week and two weeks. The survey was opened by 422 people and a total of 252 of them completed the survey and submitted their answers. The response rate was thus quite low with just over 5 %, which was expected with the chosen target group. Prior to the analysis, the research data was checked for missing observations, outliers and other deviant observations. Missing observations are values missing from one or several of the measured variables (Metsämuuronen 2011, 340). As all the questionnaire items in the survey were mandatory, the participants were unable to leave questions unanswered. Due to this, there were no missing observations present in the survey data. However, 32 respondents were removed due to minimal variation in responses to different questionnaire items, and significantly deviant answers to the question which tested whether the participant had visited the virtual store. For these respondents, it could not be ascertained whether they had actually visited the Bloomingdale's virtual store prior to answering the survey, and including these observations could affect the reliability of the results. After cleaning the data, 220 useable observations were left for the analysis.

## 3.3 Data descriptives

As the sample consisted of basic degree university students, majority (80 %) of the respondents were under 30 years old. Approximately 70 % of the respondents were between 21 and 29 years old, 10 % under 21 years, and 20 % over 30 years old. Female respondents covered 66 % of all respondents. Nearly half of the respondents reported to shop online every 3 months. Approximately 24 % shopped once a year or less, and 27 % shopped online every month. Only one respondent reported to shop online every week. Approximately 42 % of the respondents used a touch screen device to visit the virtual store and 58 % a non-touch screen device. Majority (92 %) of the respondents did not have previous experience on virtual reality stores. The characteristics of respondents are presented in Table 4.

**Table 4.** Respondent's characteristics.

| | | Frequency | Percent |
|---|---|---|---|
| **Gender** | Female | 146 | 66,4 |
| | Male | 67 | 30,5 |
| | Other | 7 | 3,2 |
| **Age** | <21 | 23 | 10,5 |
| | 21-24 | 86 | 39,1 |
| | 25-29 | 66 | 30,0 |
| | 30-34 | 23 | 10,5 |
| | 35+ | 22 | 10,0 |
| **Online shopping frequency** | Every week | 1 | 0,5 |
| | Every month | 60 | 27,3 |
| | Every 3 months | 107 | 48,6 |
| | Once a year or less | 52 | 23,6 |
| **Previous experience on VR stores** | Yes | 17 | 7,7 |
| | No | 203 | 92,3 |
| **Device type used in the experiment** | Touch screen | 93 | 42,3 |
| | Non-touch screen | 127 | 57,7 |

The means and standard deviations of the measurement items were examined to get a general view of the responses. In the concepts of *sense of presence* and *vividness of haptic imagery* the means are below 4, indicating that the responses were generally closer to "strongly disagree". However, the standard deviations for these items are quite high, meaning that there was a high degree of variation in the responses. *Autotelic NFT* and *instrumental NFT* were measured on a scale from -3 to +3. The means for these items are primarily above 0, meaning that responses were generally closer to "strongly agree", with the exception of the fifth item in instrumental NFT which has a mean below 0. The standard deviations for the items of NFT also indicate high variation in the responses. The last concept of *imagination* has mean values close to 5, suggesting that generally the respondents rated their imaginings quite vivid. The means and standard deviations for all items are presented in Table 5.

**Table 5.** Means and standard deviations of the measurement items.

| ***Sense of presence*** | *Mean* | *Std. Deviation* |
|---|---|---|
| When I finished the virtual store visit, I felt like I came back to the “real world” after a journey. | 3,18 | 1,734 |
| The virtual store created a new world for me, and the world suddenly disappeared when I finished the visit. | 3,18 | 1,699 |
| During the visit, I felt I was in the world of the virtual store. | 3,75 | 1,815 |
| During the visit, I sometimes forgot that I was in the middle of an experiment. | 2,96 | 1,753 |
| During the visit, my body was in the room, but my mind was inside the world of the virtual store. | 3,33 | 1,755 |
| During the visit, the world of the virtual store was more real or present for me compared to the “real world”. | 2,50 | 1,595 |
| The virtual store seemed to me like “somewhere I visited”, rather than “something I saw”. | 3,11 | 1,661 |
| ***Vividness of haptic imagery*** | *Mean* | *Std. Deviation* |
| I could imagine moving myself in the virtual store. | 3,18 | 1,779 |
| I felt that I could examine the textures of the products in the virtual store. | 2,77 | 1,734 |
| I felt as if the products in the virtual store were in my hands. | 2,16 | 1,418 |
| ***Autotelic NFT*** | *Mean* | *Std. Deviation* |
| When walking through stores, I can’t help touching all kinds of products. | 0,37 | 1,772 |
| Touching products can be fun | 1,53 | 1,148 |
| When browsing in stores, it is important for me to handle all kinds of products | 0,30 | 1,587 |
| I like to touch products even if I have no intention of buying them. | 0,96 | 1,688 |
| When browsing in stores, I like to touch lots of products. | 0,45 | 1,757 |
| I find myself touching all kinds of products in stores. | 0,35 | 1,826 |
| ***Instrumental NFT*** | *Mean* | *Std. Deviation* |
| I place more trust in products that can be touched before purchasing. | 1,55 | 1,345 |
| I feel more comfortable purchasing a product after physically examining it | 1,93 | 1,188 |
| If I can’t touch a product in the store, I am reluctant to purchase the product. | 0,42 | 1,513 |

| | | |
|---|---|---|
| I feel more confident making a purchase after touching the product | 1,53 | 1,251 |
| The only way to make sure a product is worth buying is to actually touch it. | -0,42 | 1,714 |
| There are many products that I would only buy if I could handle them before purchase. | 0,68 | 1,647 |
| ***Imagination*** | *Mean* | *Std. Deviation* |
| Imagine touching fur | 4,97 | 1,164 |
| Imagine touching warm sand. | 5,01 | 1,216 |
| Imagine touching a soft towel | 4,92 | 1,219 |
| Imagine touching icy water | 5,23 | 1,157 |
| Imagine touching the point of a pin. | 4,89 | 1,297 |

## 3.4 Data analysis

### 3.4.1 Confirmatory factor analysis (CFA)

The purpose of factor analysis is to group variables and reduce the fragmentation of the examined phenomenon (Metsämuuronen 2011, 666). Factor analyses include explorative factor analysis (EFA) and confirmatory factor analysis (CFA). In explorative factor analysis, a model or theory is *explored* from combinations of variables, whereas in confirmatory factor analysis a prepared model or theory is examined to *confirm* whether it is supported by the data (Metsämuuronen 2011, 683). CFA is part of structural equation modeling (SEM) and is used when the researcher has a theory on how the variables should relate to each other (Metsämuuronen 2011, 683-685). In practice, the measured variables are forced to load onto certain factors based on theory. CFA assumes variables to be multi-normally distributed and the relationships between them to be linear (Metsämuuronen 2011, 685-686). The hypotheses of this thesis are based on previous theory on the subject, which is why it is justifiable to use CFA to test the measurement validity. An adequate sample size for factor analysis is suggested at being at least five observations for each variable, and for CFA approximately 200 observations is enough in many small and medium sized models (Metsämuuronen 2011, 667, 1451). The sample of this study contains 220 observations, which exceeds the aforementioned limits and thus, indicates an appropriate sample for factor analysis. The confirmatory factor analysis was conducted with SPSS AMOS 29.

The factor loadings of the measurement items are presented in Table 6. Two items (IMAG2 and IMAG3) were removed from the imagination scale, as testing the validity of the measurement model showed an issue with the convergent validity (AVE < 0,5) of the imagination factor. Removing the items had a positive impact on the goodness of fit measures as well, as the values were under the guidelines in the original measurement model. Factor loadings closer to 1 indicate stronger load onto the factor. Factor loadings < 0,5 are considered weak. The factor loadings of the items in the redefined model are between 0,581 and 0,933, which can be defined as good. The redefined CFA model is presented in Figure 8.

**Table 6.** Factor loadings of the measurement items.

| ***Sense of presence*** | | *Standardized factor loadings* |
|---|---|---|
| SENS1 | When I finished the virtual store visit, I felt like I came back to the "real world" after a journey. | 0,750 |
| SENS2 | The virtual store created a new world for me, and the world suddenly disappeared when I finished the visit. | 0,778 |
| SENS3 | During the visit, I felt I was in the world of the virtual store. | 0,853 |
| SENS4 | During the visit, I sometimes forgot that I was in the middle of an experiment. | 0,671 |
| SENS5 | During the visit, my body was in the room, but my mind was inside the world of the virtual store. | 0,792 |
| SENS6 | During the visit, the world of the virtual store was more real or present for me compared to the "real world". | 0,703 |
| SENS7 | The virtual store seemed to me like "somewhere I visited", rather than "something I saw". | 0,690 |
| ***Vividness of haptic imagery*** | | *Standardized factor loadings* |
| HAPIM1 | I could imagine moving myself in the virtual store. | 0,709 |
| HAPIM2 | I felt that I could examine the textures of the products in the virtual store. | 0,819 |
| HAPIM3 | I felt as if the products in the virtual store were in my hands. | 0,803 |

| ***Autotelic NFT*** | | *Standardized factor loadings* |
|---|---|---|
| aNFT1 | When walking through stores, I can't help touching all kinds of products. | 0,779 |
| aNFT2 | Touching products can be fun | 0,619 |
| aNFT3 | When browsing in stores, it is important for me to handle all kinds of products | 0,781 |
| aNFT4 | I like to touch products even if I have no intention of buying them. | 0,884 |
| aNFT5 | When browsing in stores, I like to touch lots of products. | 0,933 |
| aNFT6 | I find myself touching all kinds of products in stores. | 0,913 |
| ***Instrumental NFT*** | | *Standardized factor loadings* |
| iNFT1 | I place more trust in products that can be touched before purchasing. | 0,830 |
| iNFT2 | I feel more comfortable purchasing a product after physically examining it | 0,797 |
| iNFT3 | If I can't touch a product in the store, I am reluctant to purchase the product. | 0,641 |
| iNFT4 | I feel more confident making a purchase after touching the product | 0,839 |
| iNFT5 | The only way to make sure a product is worth buying is to actually touch it. | 0,581 |
| iNFT6 | There are many products that I would only buy if I could handle them before purchase. | 0,676 |
| ***Imagination*** | | *Standardized factor loadings* |
| IMAG1 | Imagine touching fur | 0,607 |
| IMAG4 | Imagine touching icy water | 0,764 |
| IMAG5 | Imagine touching the point of a pin. | 0,802 |

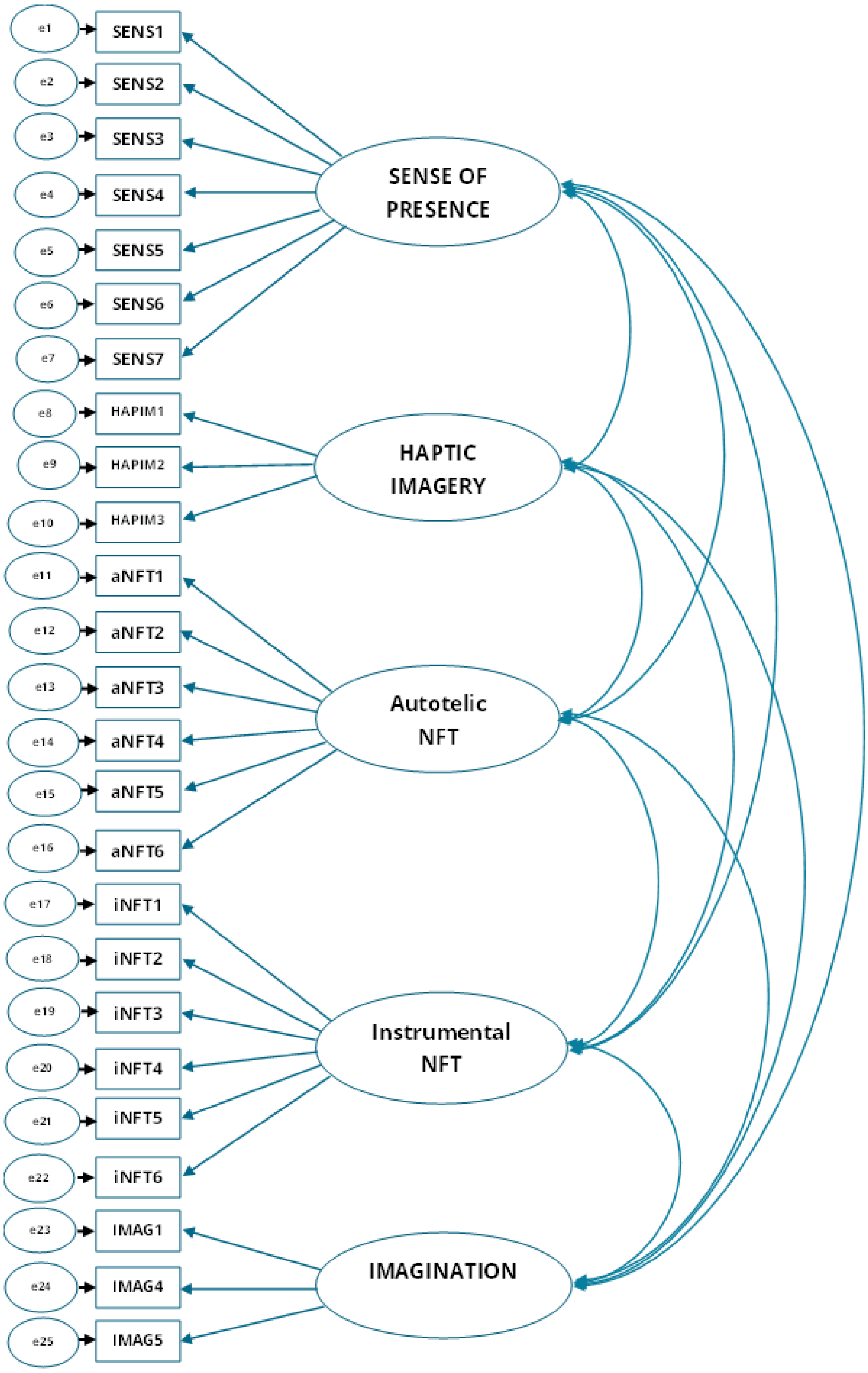


**Figure 8.** CFA measurement model.

The redefined measurement model shows acceptable fit with the data based on the goodness of fit measures presented in Table 7. Comparative fit index (CFI) varies from 0 to 1, and a value close to 1 indicates the best fit (Collier 2020, 66). In general, a value ≥ 0,9 is considered acceptable. The CFI in the model is above the threshold of 0,9 and indicates appropriate fit. With normed fit index (NFI), the desired value would be > 0,9 (Collier 2020, 66). In the model, NFI gets a value of 0,839, which is slightly under the threshold of 0,9. However, NFI is affected by sample size unlike CFI and might get lower values in the case of a smaller sample size, regardless of the model being correct (Bentler 1990). Taking into consideration that the sample size in this study is rather small, the slightly low NFI can be accepted as the other measures show a decent fit.

For root mean square error of approximation (RMSEA), values close to 0 equal the best fit (Collier 2020, 66), and a value < 0,08 can be considered a good fit. In the model, RMSEA gets a value of 0,073, which indicates an adequate fit. Other measures presented in Table 7 are relative fit index (RFI), incremental fit index (IFI), and Tucker-Lewis index (TLI). From these indexes, IFI exceeds the 0,9 limit, whereas RFI and TLI remain slightly under the limit. However, IFI is not affected by sample size (Collier 2020, 66), which might explain the lower values for the other indexes.

**Table 7.** Goodness of fit measures of the model.

| RFI | NFI | IFI | TLI | CFI | RMSEA |
|---|---|---|---|---|---|
| 0,818 | 0,839 | 0,906 | 0,893 | 0,905 | 0,073 |

The convergent and discriminant validity of the measures were assessed with a CFA correlation matrix. Convergent validity examines whether the measures converge to measure the same concept, whereas discriminant validity tests whether the measured constructs are unrelated (Collier 2020, 83). According to Fornell and Larcker (1981), convergent validity is assessed by calculating the average variance extracted (AVE) for each construct, which should be > 0,5 (Collier 2020, 83). The AVE values for all measures in the model are > 0,5 supporting convergent validity. For discriminant validity, the square root of AVE is compared to the correlations between constructs, and the value should exceed them (Collier 2020, 83). As shown in Table 8, the square roots of AVE values are greater than the correlations between constructs, thus supporting discriminant validity. Composite reliability values calculated for each factor indicate reliability based on internal consistency and act as an alternative for Cronbach’s alpha (Collier 2020, 87). The value of composite reliability should be > 0,7 (Hair, Hult, Ringle & Sarstedt 2014), which the values in this study exceed. Therefore, it can be concluded that the model does not have any validity concerns.

**Table 8.** AVE values and squared correlations.

| | Composite reliability | AVE | IMAGINATION | HAPTIC IMAGERY | PRESENCE | aNFT | iNFT |
|---|---|---|---|---|---|---|---|
| **IMAGINATION** | 0,771 | 0,532 | **0,729** | | | | |
| **HAPTIC IMAGERY** | 0,821 | 0,606 | 0,228 | **0,779** | | | |
| **PRESENCE** | 0,900 | 0,563 | 0,074 | 0,719 | **0,751** | | |
| **aNFT** | 0,926 | 0,681 | 0,210 | 0,073 | 0,115 | **0,825** | |
| **iNFT** | 0,873 | 0,539 | 0,270 | 0,087 | 0,076 | 0,529 | **0,734** |

Prior to proceeding to the primary analysis, the normal distribution of the variables was examined with the skewness and kurtosis values using descriptive statistics on SPSS. The cut-off value for the ratio of the skewness and kurtosis to their standard errors is 2 (Heikkilä 2014,163). As the values of the measured variables were within the limits, the distribution is considered to be sufficiently normal. To avoid potential multicollinearity between the independent variable and the moderating variables (Collier 2020, 223), the variables were also standardized prior to the analysis.

### 3.4.2 PROCESS Macro for SPSS

The primary analysis method in this study is moderation analysis, which bases on regression analysis. Moderation analysis is a suitable analytical strategy when the researcher wants to examine when, and under what circumstances does the independent variable affect the dependent variable (Hayes 2017, 265). In moderation, the direct effect of an independent variable on a dependent variable is altered by a moderating variable or variables (Collier 2020, 197). The moderator interacts with the independent variable and determines the effect on the dependent variable. In this “interaction term method”, an interaction term is formed of the independent variable and the moderator. This term will then indicate if the moderator significantly influences the relationship between the independent and dependent variables (Collier 2020, 197).

The moderation analysis is performed with PROCESS v4.3 by Andrew Hayes for SPSS, which also calculates the interaction terms. If the coefficient of the interaction term is not statistically different from zero, the effect of the independent variable on the dependent variable is not linearly dependent on the moderator (Hayes 2017, 236). Accordingly, if the term is statistically different from zero, the effect is linearly dependent on the moderator. When testing the moderation hypotheses, the interest is whether the moderating effect is different from zero, and thus indicates that the effect of the independent variable on the dependent variable is linearly moderated (Hayes 2017, 231). PROCESS also calculates $R^2$, which describes the extent to which the moderation of the independent variable explains the variance of the dependent variable (Hayes 2017, 238). It should be considered that $R^2$ tends to be larger with smaller samples (Hayes 2017, 56). This study applies moderated moderation, where the moderating effect of one moderator is further moderated by another moderator as shown in Figure 9. This is conducted with model 3 in PROCESS, which calculates all the needed interactions.

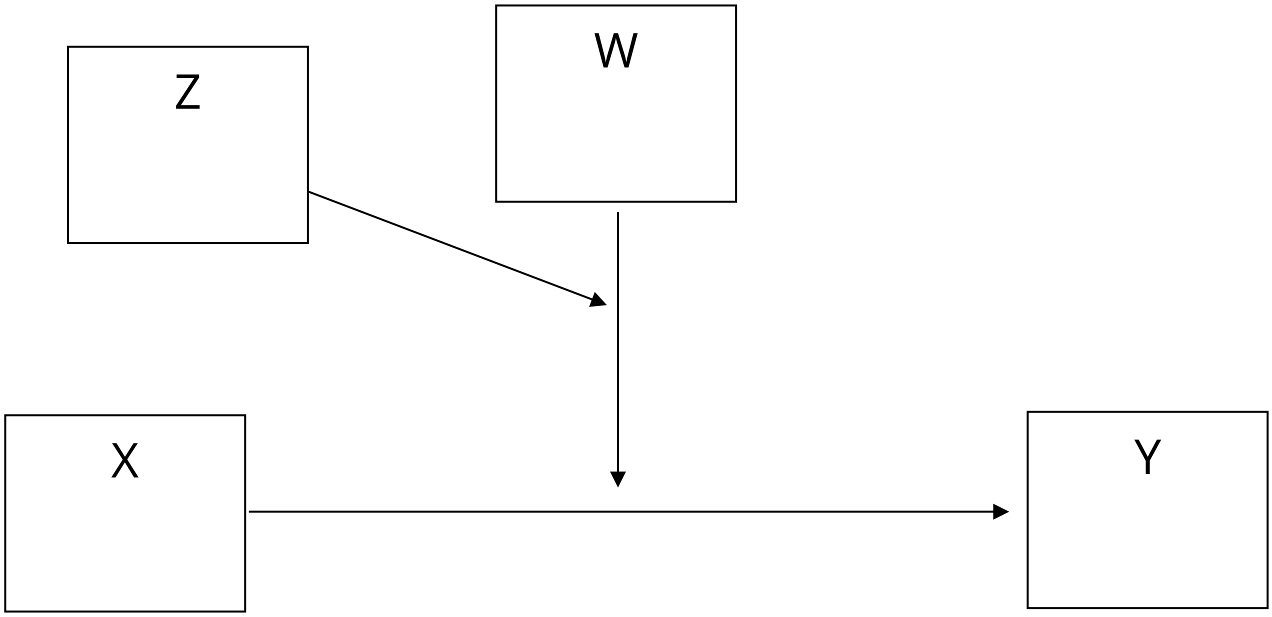

**Figure 9.** A moderated moderation model. (Hayes 2017, 331)

An important assumption in linear regression analysis is that there is no heteroskedasticity (Hayes, & Cai 2007). According to Hayes (2017, 71), mild violations of the assumption are not a major concern, however it should be taken into account. The assumption of homoskedasticity means that the variance of the regression errors is unrelated to any predicting variables or their linear combinations (Hayes & Cai 2007). Heteroskedasticity can affect the statistical significance and confidence intervals of the regression coefficients. Thus, a heteroskedasticity-consistent standard error estimator (HCSE) is used in testing the hypotheses. HCSE is a suitable method when there is no knowledge on the form of the heteroskedasticity (Hayes & Cai 2007). Hayes and Cai (2007) argue that a HC estimator should be used as a routine in linear regression models to gain comfort in the validity of the tests. PROCESS v4.3 offers several HC estimators to apply in the model, and the HC1 by Hinkley was chosen for the analysis. HC1 is equivalent to the commonly used HC0 by Huber and White, however has superior properties for smaller samples (Hayes & Cai 2007), indicating it to be a more suitable fit for this study.

# 4 Results

In testing the hypotheses, a significance level of 0,05 was applied, as it has been widely established in human sciences (Metsämuuronen 2011, 440). This implies that the null hypothesis is rejected with a 5 % risk of drawing an incorrect conclusion. This study hypothesized that haptic imagery would have a positive effect on sense of presence, and that this relationship would be moderated by need for touch and further by imagination. The two dimensions of need for touch were tested with separate analyses using the model 3 in PROCESS. Table 9 presents the results of the first moderation analysis with autotelic NFT as a moderator.

The first model tested the effect of haptic imagery on sense of presence, as well as the moderating effects of autotelic NFT and imagination. The explanatory power of the model can be considered by examining the value of $R^2$. In the first model the value is 0,446, which indicates that the model explains 44,6 % of the variance of sense of presence. The statistically significant value of the F-test ($F = 30{,}322$, $p < 0{,}001$) supports that the variables in the model explain the variation of sense of presence. The results of the first model show that the effect of haptic imagery is positive and highly significant (*coeff.* = *0,892*, $p < 0{,}001$) lending support for H1 that haptic imagery has a positive effect on sense of presence. The result of the 2-way interaction of haptic imagery and autotelic NFT is not statistically significant (*coeff.* = *0,103*, $p = 0{,}152$) and therefore, H2a is not supported. Lastly, the first model tested the 3-way interaction of haptic imagery, autotelic NFT, and imagination. The effect is not statistically significant (*coeff.* = *-0,069*, $p = 0{,}287$), and lends no support for H3a.

In model 2, the five control variables were included in the analysis with autotelic NFT as a moderator. The categorical control variables were dummy coded prior to running the analysis. The value of $R^2$ increases slightly when the control variables are included in the model and is 0,479 in model 2. The results show that the effect of device type is positive and statistically significant (*coeff.* = *0,351*, $p < 0{,}05$). Specifically, it is found that a touch screen device has a positive effect on the model compared to a non-touch screen device. The rest of the control variables are not statistically significant.

**Table 9**. Moderation analysis with autotelic NFT.

| | Model 1 | | | | | Model 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | Coeff. | p | $R^2$ | F(HC1) | F(HC1) p | Coeff. | p | $R^2$ | F(HC1) | F(HC1) p |
| **Dependent variable** | | | | | | | | | | |
| Sense of presence | | | | | | | | | | |
| **Independent variable** | | | | | | | | | | |
| Haptic imagery | 0,892 | 0,000*** | | | | 0,898 | 0,000*** | | | |
| **2-way interaction** | | | | | | | | | | |
| aNFT | 0,133 | 0,081* | | | | 0,084 | 0,294 | | | |
| **Interaction term** | | | | | | | | | | |
| Haptic imagery x aNFT | 0,103 | 0,152 | | | | 0,076 | 0,298 | | | |
| **3-way interaction** | | | | | | | | | | |
| Imagination | -0,108 | 0,108 | | | | -0,144 | 0,033** | | | |
| **Interaction terms** | | | | | | | | | | |
| Haptic imagery x Imagination | -0,124 | 0,050** | | | | -0,139 | 0,027** | | | |
| aNFT x Imagination | -0,092 | 0,197 | | | | -0,087 | 0,263 | | | |
| Haptic imagery x aNFT x Imagination | -0,069 | 0,287 | 0,446 | 30,322 | 0,000*** | -0,056 | 0,415 | 0,479 | 19,973 | 0,000*** |
| **Control variables** | | | | | | | | | | |
| Gender (ref. male) | | | | | | 0,084 | 0,625 | | | |
| Age | | | | | | -0,006 | 0,511 | | | |
| Online shopping (ref. once a year or less) | | | | | | 0,059 | 0,771 | | | |
| Previous experience (ref. no) | | | | | | 0,221 | 0,460 | | | |
| Device type (ref. non-touch) | | | | | | 0,351 | 0,018** | | | |

***p<0,001, **p<0,05, *p<0,1

The second moderation analysis tested the moderating effect of instrumental NFT, and the results are presented in Table 10. The value of $R^2$ is 0,445, which indicates that the model explains 44,5 % of the variance of sense of presence. The value of the F-test is statistically significant (*F = 28,49, p < 0,001*), supporting that the variables in the model explain the variation of sense of presence. In the first model, the direct effect of haptic imagery on sense of presence is tested. The effect is positive and highly significant (*coeff. = 0,882, p < 0,001*), similarly to the previous analysis. Second, the 2-way interaction tests the moderating effect of instrumental NFT. The interaction of haptic imagery and instrumental NFT is not statistically significant (*coeff. = 0,056, p = 0,348*), and therefore lends no support for H2b. Lastly, the model tests the 3-way interaction of haptic imagery, instrumental NFT, and imagination. The results show that the effect is not statistically significant (*coeff. = -0,004, p = 0,940*) and thus, H3b is not supported.

In model 2, the control variables are included in the analysis with instrumental NFT as a moderator. The explanatory power of the model increases as the value of $R^2$ is 0,484, indicating that the model 2 explains 48,4 % of the variance of sense of presence. This is the highest value of $R^2$ in the two analyses. The results are similar to the first analysis, as the only statistically significant control variable is the device type (*coeff. = 0,361, p < 0,05*). The results indicate that touch screen devices have a positive effect on the model compared to non-touch screen devices. A summary of the hypotheses of the study and the results of the analyses is presented in Table 11.

**Table 10.** Moderation analysis with instrumental NFT.

| | **Model 1** | | | | | **Model 2** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Variables** | Coeff. | p | $R^2$ | F(HC1) | F(HC1) p | Coeff. | p | $R^2$ | F(HC1) | F(HC1) p |
| **Dependent variable** | | | | | | | | | | |
| Sense of presence | | | | | | | | | | |
| **Independent variable** | | | | | | | | | | |
| Haptic imagery | 0,882 | 0,000*** | | | | 0,883 | 0,000*** | | | |
| **2-way interaction** | | | | | | | | | | |
| iNFT | 0,029 | 0,678 | | | | 0,018 | 0,796 | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Interaction term** | | | | | | | | | | |
| Haptic imagery x iNFT | 0,056 | 0,348 | | | | 0,051 | 0,412 | | | |
| **3-way interaction** | | | | | | | | | | |
| Imagination | -0,103 | 0,128 | | | | -0,133 | 0,055$^{*}$ | | | |
| **Interaction terms** | | | | | | | | | | |
| Haptic imagery x Imagination | -0,096 | 0,108 | | | | -0,107 | 0,085$^{*}$ | | | |
| iNFT x Imagination | -0,109 | 0,077$^{*}$ | | | | -0,126 | 0,037$^{**}$ | | | |
| Haptic imagery x iNFT x Imagination | -0,004 | 0,940 | 0,445 | 28,490 | 0,000$^{***}$ | -0,019 | 0,701 | 0,484 | 21,159 | 0,000$^{***}$ |
| **Control variables** | | | | | | | | | | |
| Gender (ref. male) | | | | | | 0,102 | 0,555 | | | |
| Age | | | | | | -0,010 | 0,281 | | | |
| Online shopping (ref. once a year or less) | | | | | | 0,068 | 0,741 | | | |
| Previous experience (ref. no) | | | | | | 0,275 | 0,360 | | | |
| Device type (ref. non-touch) | | | | | | 0,361 | 0,015$^{**}$ | | | |

$^{***}p<0,001$, $^{**}p<0,05$, $^{*}p<0,1$

**Table 11.** Summary of the hypotheses of the study.

| | |
|---|---|
| **H1** Haptic imagery strengthens sense of presence in a virtual environment. | Supported |
| **H2a** Greater autotelic NFT weakens the relationship between haptic imagery and sense of presence. | Not supported |
| **H2b** Greater instrumental NFT weakens the relationship between haptic imagery and sense of presence. | Not supported |
| **H3a** Imagination moderates the negative effect of autotelic NFT on the relationship between haptic imagery and sense of presence. | Not supported |
| **H3b** Imagination moderates the negative effect of instrumental NFT on the relationship between haptic imagery and sense of presence. | Not supported |

# 5 Discussion and conclusions

## 5.1 Theoretical conclusions

The purpose of this study was to shed light on the role of consumer's imagination in virtual shopping and contribute to the research on consumer behaviour and digital sensory marketing. The main research problem addressed in this study, was if imagination could compensate for the sense of touch in a virtual environment. The main research question was approached through three sub-questions considering the effects of haptic imagery, need for touch, and imagination on the experienced sense of presence. This study pursued to answer the research questions with a comprehensive review on previous research literature, and by conducting an empirical study. As consumers' psychological responses to VR shopping have not yet been widely researched (Han et al. 2020; Lee et al. 2022), this study contributes with a better understanding on how imagination affects the VR shopping experience.

A successful VR experience can result in better brand attitudes, increased purchase intentions, and comfort in decision making (Choi et al. 2016; Gatter et al. 2021). The experience is largely affected by sense of presence, which contributes to an enhanced online sensory experience through cognitive immersion (Rose et al. 2012) and improved tangibility (Cowan & Ketron 2019). Based on the literature review, tangibility can be identified as an essential element in creating virtual sensory experiences, as it is suggested to enhance sensory imagery and information processing, leading to stronger sense of presence. Accordingly, lack of mental tangibility can prevent consumers from imagining the sensorial features of the products (Kaushik & Gokhale 2022). Sufficient visual information and evoked imaginings can assist in decision making when physical examination is not possible (Klatzky et al. 1993). By developing the visual features and sensory-richness of content on shopping sites, the frustration caused by limited sensory information can be reduced. Realistic, three-dimensional product visualizations increase informativeness (Kang et al. 2020) and tangibility, and thus assist in visualizing the products and their haptic features through enhanced haptic imagery (Liu et al. 2019; Hamacher & Buchkremer

2022). Vivid visual stimuli and the interactivity of a virtual environment activate consumer's imagination, leading to a similar sensation as a real sensory experience (Overmars & Poels 2015; Cowan & Ketron 2019).

The empirical study was conducted with a quantitative research method, examining the effect of haptic imagery on sense of presence, as well as the moderating effects of autotelic and instrumental need for touch, and imagination. The hypotheses were derived from previous research and theory and aimed to further examine the impact of consumers' imagination on virtual experiences. The research data was collected with an online survey targeting students from the University of Eastern Finland (UEF). A confirmatory factor analysis (CFA) was conducted using SPSS AMOS 29, and the primary method of a moderated moderation analysis was performed with model 3 on PROCESS Macro for SPSS.

The first contribution this study makes is to demonstrate the impact of vivid haptic imagery on the experienced sense of presence. Previous research, such as Iachini et al. (2019), have found vivid imaginings to positively correlate with stronger sense of presence. Haptic imagery is found to activate the same regions of the brain as a physical experience, causing a similar sensory perception (Barsalou 2008; Yoo et al. 2003; Anema et al. 2012; Peck et al. 2013; Gatter et al. 2021; Hamacher & Buchkremer 2022), which could explain the connection to stronger sense of presence in the context of a virtual environment. The results of this study support the findings of previous research by emphasizing the positive effect of haptic imagery on sense of presence. The results show that consumers with more vivid haptic imagery in the virtual store, also experienced stronger sense of presence. Haptic imagery is found to be triggered by vivid visual stimuli (Petit et al. 2019; Lee et al. 2022), which is consistent with the results of this study, as a visually stimulating virtual store enabled vivid haptic imagery, which further contributed to stronger sense of presence. Therefore, the results support the link presented in previous research (Iachini et al. 2019) from the vividness of the technology to the vividness of imagination, and further to the experienced sense of presence.

The second contribution of this study is to add insight into the effect of the two dimensions of need for touch (NFT) on the relationship between haptic imagery and sense of presence. The purposed moderating effect of NFT was based on the findings of previous research on the negative effect of high NFT on virtual and online shopping. Autotelic NFT is previously found to have a negative effect on the relationship between sense of presence and consumer's attitude in a virtual store (Ruusunen et al. 2023), presumably due to the difficult implementation of hedonic benefits of touch in virtual stores. Moreover, consumers with instrumental NFT are suggested to consider physical touch as the only valid way to evaluate products (Gatter et al. 2021), and high NFT has also been associated with the general preference for physical stores (Kühn et al. 2020). However, the results of this study do not lend support for the findings in previous research, as no significant moderating effect is found for either of the NFT dimensions. Therefore, to make informed conclusions the effects of the two dimensions should be studied more.

Thirdly, this study contributes to the little-explored interplay between imagination and NFT. Consumer's imagination is suggested to provide additional information when real product interaction is not possible (Liu et al. 2019). This is based on visual stimuli and interactivity guiding consumers to imagine the haptic elements, resulting in tactile sensations similar to physical experiences (Overmars & Poels 2015). Seeing a realistic representation of a product activates mental simulation based on previous sensory experiences (Petit et al. 2019). Consumer's imagination is previously found to assist in compensating for instrumental NFT in a virtual store, but not autotelic NFT (Ruusunen et al. 2023). The results of this study, however, did not show a statistically significant moderating effect of imagination on the relationship between NFT, haptic imagery, and sense of presence. Based on the inconsistency of the results in previous research and this study, it can be stated that the interplay between imagination and NFT in virtual environments should be studied further before conclusions can be drawn.

Finally, this study demonstrated the impact of the used device type on the virtual shopping experience by examining it as a control variable in the research model. Previous research has found interaction with touch screen devices to enhance haptic imagery and result in feelings of actual touch, contrary to interaction with non-touch devices, such as mouse-operated computers

(Liu et al. 2019; Lee & Choi 2021). The results of this study showed touch screen devices to have a positive effect on the research model compared to non-touch screen devices. Therefore, the outcome of the model: sense of presence, was stronger for participants who had visited the virtual store through a touch screen device.

## 5.2 Managerial implications

As virtual reality is becoming more accessible and gaining interest among retailers (Kang et al. 2020), this study contributes by demonstrating the impact of consumer's imagination on the virtual shopping experience. VR technologies are gradually shaping the future of online shopping and offer possibilities to develop e-commerce by providing consumers with interesting digital features and entertaining experiences. However, as haptic devices have not yet been commercialized, online and virtual environments are unable to offer real haptic information. Previous research on the connections between consumers' imagery and perception has provided insights into how consumer's sensory experiences could be influenced through imagination. The findings of this study demonstrated this by showing that consumers' vivid haptic imagery, enabled by a visually stimulating virtual store, led to stronger sense of presence.

One of the main problems in online environments is the perceived intangibility, which prevents consumers from visualizing the products and their sensorial features (Kaushik & Gokhale 2022). Increasing the tangibility of virtual environments increases consumers' sensory imagery and can thus be seen as an important aspect to consider when creating virtual experiences. Interactive features and realistic visual presentations are suggested to increase the perceived tangibility (Cowan & Ketron 2019; Liu et al. 2019). By providing dynamic, three-dimensional visual content, and increasing the use of sensory cues, companies can promote consumers' sensory imagery and information processing through the increased tangibility. Improving the interactivity of virtual product experiences affects the controllability and responsiveness of the virtual environment, which is a key element in achieving a similar experience to real product examination (Blazques Cano et al. 2017). By creating vivid virtual environments with realistic product presentations companies can enhance engagement, informativeness, and consumers' attitudes (Park et al. 2019; Cowan & Ketron 2019; Kang et al. 2020; Azayat & Lee 2021), through the evoked sensory imagery and sense of presence. With investments in interactive, visual, and sensory-rich content, companies can assist consumers in visualizing the products and their sensorial features, and thus increase decision confidence, leading to improved behavioural intentions.

Certain product features appeal to consumers more than others, and are also easier to imagine, which is suggested to be considered in virtual product presentations. Product features, such as smoothness and simple shapes are found to appeal to consumers more, compared to rough textures and complex shapes (Klatzky & Peck 2012). Already familiar products and settings create more vivid imagery, as consumers recall previous experiences from their memory (Peck et al. 2013; Iachini et al. 2019). Therefore, creating interactive environments with a similar atmosphere that would be achieved in physical stores, and with product presentation that appeal to consumers' senses, could contribute to enhanced imagination and improved sensory experience. Another approach that could be easily introduced by retailers to activate consumers' haptic imagery, is content with vicarious touch (Pino et al. 2020; Jiang et al. 2024). Seeing another person touching a product generates a "mirror-touch" effect, as consumers visualize themselves touching the product. With sensory-rich tactile compensation content, companies can affect consumers' perception of sensory similarity (Jiang et al. 2024) and improve decision making by reducing the perceived risk of dissatisfactory purchase.

Many features that would increase haptic imagery, are not yet widely adopted by companies (Hamacher & Buchkremer 2022). These features include for instance, three-dimensional product visualizations, product videos, and virtual try-ons. Incorporating these features into e-commerce could provide competitive advantage by enabling a better sensory experience through enhanced sensory imagery. Jiang et al. (2024) also disclosed that consumers acknowledge companies' efforts to provide technological solutions, and thus present more positive behavioural intentions and evaluations towards those companies. The findings of this study support that the features in a visually stimulating virtual store can provide consumers with vivid haptic imagery and lead to stronger sense of presence, which could further result in better attitudes, experiences, and purchase intentions.

## 5.3 Limitations and future research

This study was conducted as a master's thesis and thus, has some limitations that might affect the generalizability of the results. For the theoretical background, a considerable amount of previous research literature was reviewed, and the key findings were presented in Table 2. As the literature review was not conducted systematically, some relevant studies may have gone unnoticed. However, a comprehensive overview of previous studies was still presented. The survey questionnaire used in the data collection was conducted in English to prevent any possible problems related to the translation of survey questions. However, the majority of the target group were Finnish speakers, and therefore it is possible that the respondents had different perceptions on the meaning of certain concepts or questions, as the English concepts were not defined on the survey form.  Thus, in future research it is to be considered how to minimize possible misunderstandings related to the terminology.

The final sample of 220 respondents was relatively small, although an acceptable size for the chosen analysis methods. A larger sample would increase the reliability of the results and could reveal possible moderating effects that were not found in this study. The response rate was also quite low, at just over 5 %, as was expected for the chosen target group. In addition, the respondents were quite close to each other in terms of age, which prevented the detection of possible effects of age on the results. Since age can affect for instance, the "digital nativity" of consumers, future research should consider examining a wider age range to reveal possible effects on the virtual experience. The reliability of survey data is dependent on the stability of the responses, which means that the respondents would answer the same way if the questions were asked again. 32 respondents were removed from the survey data prior to the analysis due to minimal variation in responses and deviant answers, to prevent negative effects on the reliability of the results. However, in the case of a survey, it cannot be stated with certainty that no untruthful answers were left in the data. These limitations should be acknowledged when considering the representativeness and generalizability of the results.

Lastly, it must be noted that in the analysis phase, the concept of imagination was modified by removing two items, and the goodness of fit indicators were in part, slightly lower than was desired. Also, since the empirical study was not carried out in a controlled laboratory condition, the virtual store experience, as well as participants’ focus on the survey, may have been affected by external distractions. This is of course, inevitable in real-life virtual shopping situations as well, since they take place in consumers’ chosen locations that cannot be controlled by the retailer. Despite the limitations, the analysis model showed a high explanatory power, which peaked at 48,4 %, indicating that the measured concepts explained each other. However, the study should be repeated with a larger sample to make better conclusions.

This study was conducted using a virtual store that was accessed through a mobile-device or a desktop computer, which is considered a low-immersive VR environment. For future research, it could be beneficial to examine the research setting in the context of a high-immersive environment, using for instance HMDs. With different sensory-enabling technologies (SETs), such as AR-devices and wearable VR-devices, slowly making their way into consumers’ lives, opportunities arise to examine the effects of these technologies on the virtual consumer experience. Future research could compare the possibilities of different technologies in stimulating consumer’s imagination and evoking sensory imagery. A comparative study in terms of the media richness theory (MRT) could also be conducted by comparing the virtual shopping experiences in a richer media environment, such as a VR store with HMD, and in a less rich environment, such as a 360-store. The results of this study suggested that the device consumers used would affect the virtual experience, which proposes an area for further research on the effects of different devices on sense of presence and sensory imagery.

The Bloomingdale’s virtual store used in this study could be seen as a more “playful” environment, as the store does not mimic a real store, and might be perceived as more of a hedonic experience rather than an informative purchase environment. Therefore, the same research model could be examined in a different virtual store to see whether the results would be different. Multisensory experiences are often context-specific for the user (Mishra et al. 2021), which would advocate repeating the study in another virtual store. The product selection at Bloomingdale's is also more high-end, and on the expensive side, which might conflict with the target group of university students. Future research could thus consider participants' motivation towards the products as this might affect the results. Also, the chosen virtual store did not enable the rotation of the products for evaluation, although they were presented in three-dimensional, which could be taken into consideration in future research as this feature might affect the perceived informativeness. The realism of the virtual environment, as well as the familiarity of the products is previously found to affect the vividness of imagination (Peck et al. 2013; Iachini et al. 2019), which would indicate that a more realistic virtual store could provide different results.

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# Appendix 1

## Survey questionnaire

Sense of presence (Kim & Biocca 1997).

| | Strongly disagree (1) | | | | | | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| When I finished the virtual store visit, I felt like I came back to the “real world” after a journey. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The virtual store created a new world for me, and the world suddenly disappeared when I finished the visit. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| During the visit, I felt I was in the world of the virtual store. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| During the visit, I sometimes forgot that I was in the middle of an experiment. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| During the visit, my body was in the room, but my mind was inside the world of the virtual store. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| During the visit, the world of the virtual store was more real or present for me compared to the “real world”. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The virtual store seemed to me like “somewhere I visited”, rather than “something I saw”. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Vividness of haptic imagery (Peck, Barger & Webb 2013).

| | Strongly disagree (1) | | | | | | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I could imagine moving myself in the virtual store. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I felt that I could examine the textures of the products in the virtual store. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I felt as if the products in the virtual store were in my hands. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Need for touch (Peck & Childers 2003).

| A=autotelic I=instrumental | Strongly disagree (-3) | | | | | | Strongly agree (+3) |
|---|---|---|---|---|---|---|---|
| When walking through stores, I can't help touching all kinds of products. (A) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Touching products can be fun. (A) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| When browsing in stores, it is important for me to handle all kinds of products. (A) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I like to touch products even if I have no intention of buying them. (A) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| When browsing in stores, I like to touch lots of products. (A) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I find myself touching all kinds of products in stores. (A) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I place more trust in products that can be touched before purchasing. (I) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| I feel more comfortable purchasing a product after physically examining it. (I) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| If I can't touch a product in the store, I am reluctant to purchase the product. (I) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I feel more confident making a purchase after touching the product. (I) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The only way to make sure a product is worth buying is to actually touch it. (I) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| There are many products that I would only buy if I could handle them before purchase. (I) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Imagination (Andrade, May, Deeprose, Baugh & Ganis 2014).

| Imagine touching... | No image at all (1) | | | | | | As vivid as real life (7) |
|---|---|---|---|---|---|---|---|
| Fur. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Warm sand. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| A soft towel. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Icy water. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The point of a pin. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |