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Virtual Try-On Technologies in the Beauty Industry: Consumer Perception

Inês Filipa Pires Ferreira Marques

Master's in Digital Technologies for Business

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TECNOLOGIAS
E ARQUITETURA

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Resumo

A integração de tecnologias de VTO nos canais de comércio eletrónico revolucionou a forma como os consumidores interagem com os produtos de beleza, permitindo-lhes testar e visualizar virtualmente como estes produtos ficam no seu rosto, sem a necessidade de os aplicar fisicamente. Esta dissertação tem como objetivo compreender o impacto destas tecnologias na intenção de uso e compra dos consumidores, bem como compreender os principais desafios enfrentados pelos mesmos. A nossa investigação experimental compreendeu a análise do impacto das perceções dos consumidores sobre o VTO da marca M·A·C Cosmetics, tendo em conta duas condições distintas: fotografia personalizada vs. fotografia não personalizada. No nosso estudo foram incluídas não só medidas quantitativas previamente abordadas por outros investigadores (e.g., Divertimento Percebido e Facilidade de Uso Percebida), como também foram criadas medidas quantitativas originais (e.g., Variações por Produto Testadas e Tempo Despendido na Plataforma). Foram ainda incluídas medidas qualitativas por forma a obtermos uma compreensão mais profunda do nosso tema. Concluímos que, apesar dos consumidores de uma maneira geral terem uma perceção positiva acerca destas tecnologias, ainda existem alguns desafios a ser ultrapassados (e.g., efeitos irrealistas e imprecisão de posicionamento do produto no rosto). Apesar de não terem sido encontradas diferenças significativas na maioria das medidas quantitativas entre as duas condições, (com exceção de duas delas: Divertimento Percebido e Variações por Produto Testadas) o nosso estudo mostrou-nos caminhos importantes que os *stakeholders* da indústria poderão seguir por forma a otimizarem a satisfação dos seus consumidores e por conseguinte, alavancarem os seus negócios.

Palavras-chave:

Prova virtual, Cosmética, Maquilhagem, Comportamento do Consumidor, Perceção do Consumidor, Intenção de Compra.

Abstract

The incorporation of VTO technologies into e-commerce channels has revolutionised the way consumers interact with beauty products, enabling them to virtually test and visualise how these products appear on their faces without having to physically apply them. This dissertation aims to investigate the impact of these technologies on consumers' usage and purchasing intentions, as well as the main challenges they encounter while interacting with them. Our experimental investigation examined the impact of consumer perceptions of the VTO from the M·A·C Cosmetics brand under two distinct conditions: personalised picture vs. non-personalised picture. Our study included both previously examined quantitative measures by other researchers (e.g., Perceived Enjoyment and Perceived Ease of Use) and original quantitative measures that were created by us (e.g., Variations per Product Tested and Time Spent on the Platform). Qualitative analysis was also included to gain a better understanding of our research topic. We concluded that, although consumers had an overall positive perception of these technologies, there are still some challenges to overcome (e.g., VTO's unrealistic effects and product displacement on the face). Even though no significant differences were found in the majority of the quantitative measures between the two conditions, (except for two measures: Perceived Enjoyment and Variations per Product Tested) our research revealed important directions that industry's stakeholders could consider following to enhance their consumers' satisfaction and consequently, boost their businesses.

Keywords:

Virtual Try-On, Cosmetics, Makeup, Consumer Behaviour, Consumer Perception, Purchase Intention.

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List of Abbreviations

AI – Artificial Intelligence

AR – Augmented Reality

BI – Behavioural Intentions

CI – Confidence Interval

DL – Deep Learning

LB – Lower Bound of the 95% Confidence Interval

M – Mean

ML – Machine Learning

PAQ – Perceived Augmented Quality

PE – Perceived Enjoyment

PEU – Perceived Ease of Use

PU – Perceived Usefulness

SD – Standard Deviation

UB – Upper Bound of the 95% Confidence Interval

VTO – Virtual Try-On

Chapter 1
Introduction

Throughout history, cosmetics have been used by women across various cultures and civilisations, to enhance their beauty, primarily on the face, as an essential aspect of self-expression and identity, shaping their perception of reality. The concept of beauty has evolved over time, influenced by diverse traditions, and explored through art, media, and societal standards [1].

In recent years, the beauty industry has experienced a significant digital transformation, which has been driven by advancements in technology and changes in consumer behaviour [2]. As more consumers become digitally literate, online shopping continues to grow in popularity, and companies are increasingly investing in beauty technology to modernise their operations and meet the changing demands of their consumers [2]. The integration of VTO technologies has been a significant factor in this transformation, as it has changed the way consumers interact with beauty products [3]. Incorporating augmented reality technology into virtual makeup application systems allowed users to visualise the results of their product application quickly and accurately [4], without needing to physically apply the products. Specifically, products may be virtually applied using either the face of a model (e.g., M·A·C Cosmetics[1] website[2], which provides 6 pictures of models from varied ethnic backgrounds) or the user's own face. Nevertheless, despite the progress made, there are still challenges such as the ability to create realistic experiences as some constraints in user engagement are reported [6], emphasising the need to explore the factors influencing VTO experience evaluation and its impact on the shopping experience [7]. As technology continues to advance and become more widely used, it is increasingly important to understand its influence on consumers' purchase decisions and the challenges faced when using virtual makeup try-on technologies.

1.1 Context

It is estimated that the beauty industry will achieve retail sales of approximately $491 billion by 2024, with a projected annual growth rate of 6%, as illustrated in Figure 1. This growth is expected to continue, reaching a global retail sales figure of around $580 billion by 2027 [8]. Geographically, Asia

[1] M·A·C Cosmetics (one of the most recognized makeup brands worldwide) is a subsidiary brand of Estée Lauder Companies. [5]
[2] Link to M·A·C VTO platform website: https://www.maccosmetics.com/virtual-try-on

Pacific has been assuming the leading market position, followed by the US, while emerging markets like India and the Middle East present promising growth opportunities for beauty brands [8].

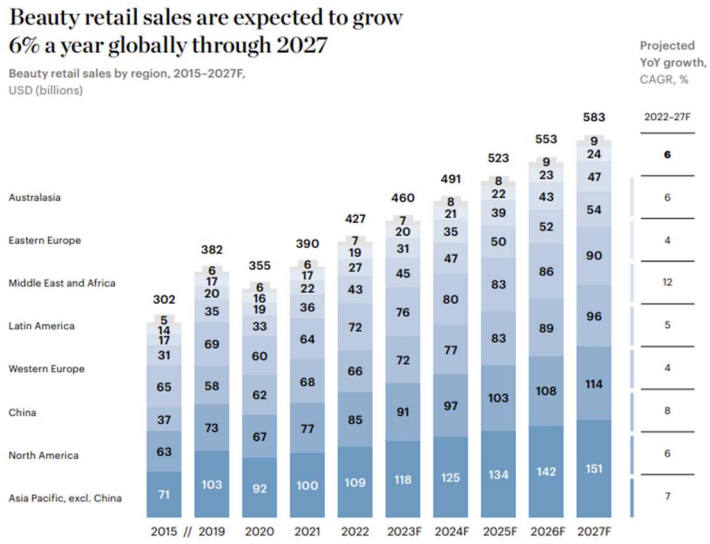


Figure 1 – McKinsey & Company report on expected beauty retail sales evolution until 2027 [8]

Beauty Product Categories

The beauty industry covers various categories, including skincare, makeup, fragrance, and hair care. The skincare category (e.g., Face creams, and Serums) is the leading segment in the beauty industry, and it is projected to reach a value of $260 billion by 2027 [8]. The hair care category (e.g., shampoos, and conditioners) is the second leading category in this industry with total retail sales projected to reach $120 billion, followed by the makeup category (e.g., foundations, and lipsticks), expected to make a strong comeback after experiencing a decline during the pandemic and with projections to surpass $105 billion by 2027 [8]. Finally, it is anticipated that sales of fragrances (e.g., eau de parfum, and eau de toilette) will approach $100 billion, primarily due to their growing popularity in China [8].

E-commerce and VTO

In recent years, e-commerce has had a significant impact on the global beauty industry all over the world, with a consistent increase in global e-commerce sales from 2015 to 2022, at a compound annual growth rate of 20 % [8], further accelerated by the Covid-19 pandemic that contributed to a significant increase in the number of sales through this channel [9].

As of 2022, e-commerce has taken the lead as the primary sales channel worldwide, surpassing other significant channels, accounting for approximately 20% of the industry's total sales [8]. Meanwhile, the presence of other major channels is diminishing, as illustrated in Figure 2, the e-commerce channel is projected to reach a quarter of the market by 2027.

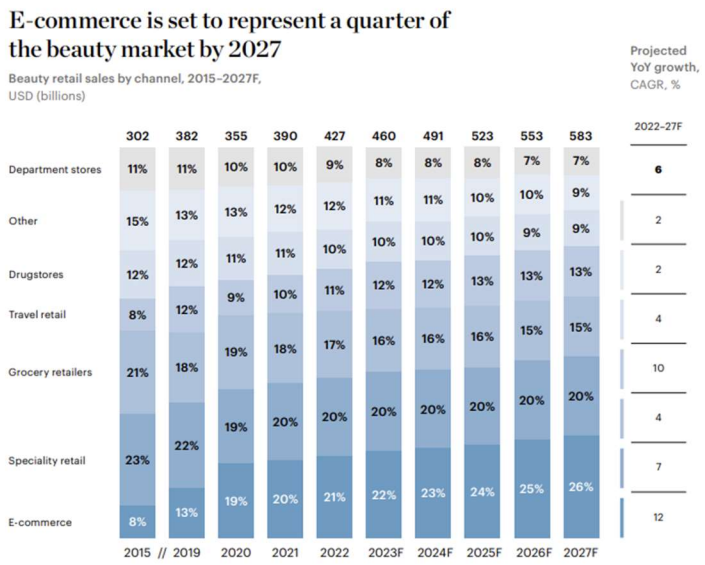


Figure 2 – McKinsey & Company report on expected beauty e-commerce sales evolution until 2027 [8]

As a result of the beauty industry being predominantly driven by e-commerce, there has been a consequent increase in the integration of VTO technologies, enabling customers to virtually test beauty products [6], such as lipstick, lip gloss, eyeshadow, blush, and foundation [10].

Nevertheless, the implementation of these technologies encounters technical challenges, including real-time rendering, facial tracking, and adapting to different lighting conditions [9], which can impact the overall consumer experience [6].

1.2 Problem Statement

Through our study, we seek to explore consumers‘ perspectives on VTO technologies, investigating the **impact of virtual makeup try-on technologies on consumers' usage and purchase intentions**[3] and **identifying the key challenges they face when using such technologies**[4]. Critically, we examined whether using the self-consumer picture (vs. a picture of a model) impacted the VTO experience outcomes, combining quantitative (e.g., ratings of Perceived Usefulness and Enjoyment) and qualitative measures (e.g., main perceived advantages/disadvantages). Aligning with the growing trend of e-commerce in the beauty industry, by understanding these insights from consumers, we aim to provide stakeholders recommendations to adapt VTO strategies and optimise their implementation.

[3] Referring to the Research Question: **“What is the impact of virtual makeup try-on technologies on consumers' usage and purchase intentions?”**

[4] Referring to the Research Question: **“Which key challenges do consumers face when using VTO technologies?”**

1.3 Dissertation Outline

This dissertation includes six chapters, with the first one focusing on introducing and contextualising the research topic being analysed. The second chapter focuses on the literature review of the pertinent concepts and knowledge required to conceptualise this dissertation. The third chapter presents the conceptual framework and hypotheses, while the fourth chapter describes the methodology used to conduct the research study.

The fifth chapter is the results chapter, thus presenting an analysis of the research results to answer the proposed research questions. Finally, in the sixth chapter, we evaluate the research conclusions, discuss their limitations, and provide recommendations both for future researchers and for the beauty industry's stakeholders.

Chapter 2
Literature Review

A literature review was conducted focusing on specific topics and utilising a systematic approach to search and analyse articles and studies from relevant databases such as Web of Science, Scopus, and Google Scholar.

The literature review was divided into two main parts, each focusing on specific topics. Firstly, an overview of the VTO technologies in the beauty industry, and secondly, an overview of previous studies on consumer behaviour regarding the usage of VTO technologies, where the PRISMA methodology [11] was employed. In addition, Zotero software [12] was used for the data management and storage in both scenarios. Furthermore, additional literature was reviewed to provide us with insights for framing our investigation.

2.1 Virtual Try-On Technologies in the Beauty Industry

The incorporation of Augmented Reality and Artificial Intelligence based VTO technologies is increasing in the beauty industry due to their ability to increase sales and enhance consumer engagement [10]. By implementing hyper-realistic VTO experiences on websites, consumers can instantly try on numerous makeup products, including lipstick, eyeshadow, mascara, highlighter, and foundation [10]. In this context, AR has emerged as a technology to enhance the shopping experience, where consumers can try on multiple beauty products in real time. It is a technology that combines computer-generated virtual elements with the real-world environment, merging virtual and real environments by overlaying virtual elements onto the user's physical environment [5]. It offers an innovative way to engage consumers by allowing them to interact with virtual products, creating experiential value through simulations and media richness, influencing their purchase intentions [5]. While VTO technologies are expected to efficiently simulate various combinations of cosmetic products, their implementation on a device presents a challenging task that involves facial tracking, understanding lighting conditions, and rendering real-time makeovers, all within the confines of a restricted computational environment [9].

Facial tracking

Figure 3 – Illustration of Facial Tracking in VTO [13]

As illustrated in Figure 3, facial tracking technology (i.e., recognition of facial features), is crucial for a fully immersive AR experience, particularly in beauty VTO scenarios, since its users expect to be able to move their heads and see the virtual makeup from different angles, just like they would in front of a mirror [10].

Colour and Lighting Environment

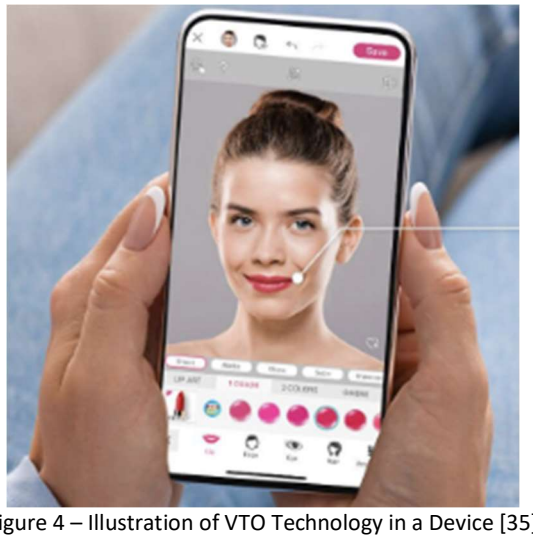


Figure 4 – Illustration of VTO Technology in a Device [35]

The perception of colour is determined by the interaction of light's distribution across various wavelengths with the light receptors in our eyes and can be associated with objects based on their physical attributes, including light absorption and reflection. Nevertheless, and as illustrated in Figure 4, in the context of VTO, the colour is received from a display rather than a real material [10].

Rendering

Figure 5 – Illustration of Facial Rendering in VTO [13]

As illustrated in Figure 5, VTO technologies allow users to visualise how various shades and material types like matte, satin, or glossy would look on them, considering not only the colour's precision but also how they blend with their lip texture [10].

Skin tone

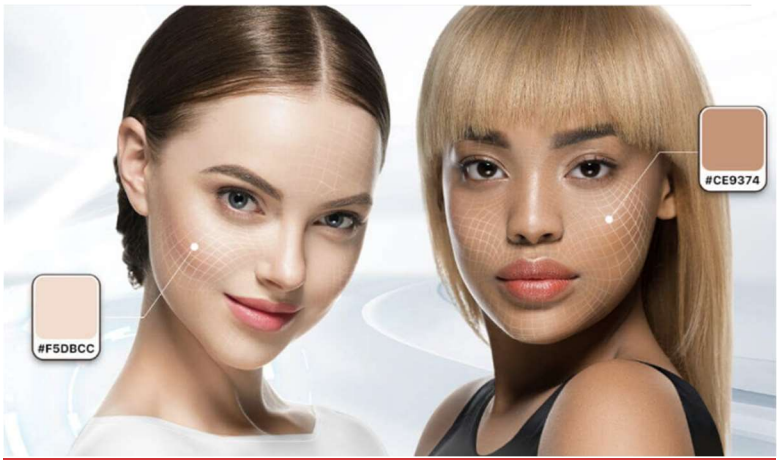


Figure 6 – Illustration of Skin Colour Detection in VTO [35]

The choice of a foundation shade usually involves matching its colour with the user's real skin tone. In this context, deep learning technology utilises a knowledge base of skin tones to assist in finding the foundation shade in real-time. Deep learning is a subfield of machine learning, which is a subfield of artificial intelligence that focuses on building and training artificial neural networks with multiple layers to learn and represent complex patterns and relationships in data [14]. As illustrated in Figure 6, this

advanced system detects and analyses the unique characteristics of individuals' skin tones, enabling personalised recommendations for foundation shades [10].

Leading beauty brands and VTO

Aligned with its digital acceleration strategy, in 2018, L'Oreal, the world's largest cosmetics and beauty company [15], acquired the whole share capital of Modiface [16], a Canadian-based tech company acknowledged for the use of AR and AI within the beauty industry [17].

Following similar steps, in 2022, M·A·C Cosmetics, a world-leading brand of makeup products within the Estée Lauder Companies group [5], partnered with Perfect Corp, a Taiwan beauty tech-based company that also integrates AI and AR technologies into their VTO solutions [18].

Although the Estée Lauder Companies provide a wide portfolio of high-end beauty products, including fragrances, haircare, and skincare, their makeup category is one of the most lucrative categories along with their skincare [19]. Also, as Estée Lauder desires to maintain their market relevance and representativity across all generations, one of their most preferred brands among younger generations is M·A·C Cosmetics. As we expected to include young participants in our study (undergraduate students), this brand (M·A·C Cosmetics) was chosen for the experiment.

2.2 Consumer Behaviour Studies

2.2.1 Search Strategy and Inclusion

To analyse previous studies on consumer behaviour in the literature, we employed the PRISMA methodology, as illustrated in Figure 7. For this purpose, relevant articles were searched in Scopus and Web of Science databases, focusing on the years between 2018 and 2022. The search query used was: (("augmented reality" OR "virtual try-on" OR vto) AND (makeup OR beauty OR cosmetics) AND (consumer OR behavior OR behaviour OR "decision-making" OR purchase)).

After removing duplicate entries, the search query retrieved a total of 31 records. We then proceeded to screen out irrelevant records by analysing titles, abstracts, and availability, resulting in 15 remaining studies. After a thorough examination of the full text of these articles, we identified 9 documents that were pertinent to our study.

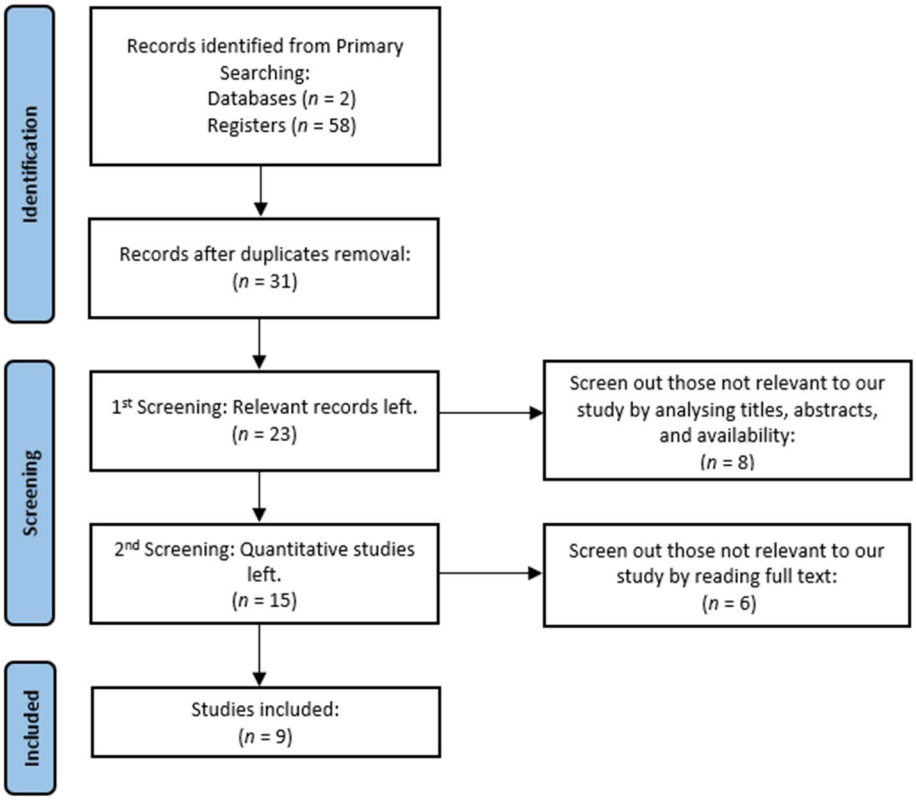


Figure 7 – PRISMA Workflow Diagram

2.2.2 Overview of the Studies

Within the 9 selected documents, to provide a concise overview, Table 1 summarises those with their respective interest dimensions and our intended contribution. In our study, we aim to provide a comprehensive analysis by including not only previously investigated dimensions but also contributing new insights by assessing variables that have not been previously examined.

Table 1 – Consumer Behaviour Studies with VTO Technologies

Studies	[3]	[7]	[9]	[20]	[21]	[22]	[23]	[24]	[25]	Our study
Year	2021	2022	2021	2022	2021	2022	2020	2021	2022	2024
Augmentation Quality	X	X	X	X	X	X	X		X	X
Usefulness		X	X	X		X		X		X
Ease of Use						X		X	X	X
Enjoyment	X	X	X	X		X	X	X	X	X
Behavioural Intentions	X	X	X	X	X	X	X		X	X
Ethical and Privacy Concerns										X
Number of Products Tested										X
Variations per Product Tested										X
Time Spent on the platform										X
Personalised VTO	X	X	X	X		X	X		X	
Personalised versus Non-Personalised VTO comparison					X					X
Laboratorial experiment										X

2.2.2.1 Relevant Dimensions from Existing Literature

Through our systematic review, we have selected several dimensions that we identified as relevant to answer our research questions. Subsequently, we present a brief description of each one of them.

Perceived Augmentation Quality

Authors in [20, p.899] define perceived augmented quality as "the extent to which an individual perceives the augmented content as realistic", referring to the extent to which the virtual content in the AR experience feels realistic, leading to a sense of immersion that replicates real world experiences. Therefore, when users have a positive experience with AR and perceive it as realistic and immersive, their motivation to use the technology increases [20].

Perceived Usefulness

Perceived usefulness is defined by authors in [24], as the extent to which users believe that using AR-based technologies improves their performance or provides value in their shopping experience, leading them to an higher intention to use these technologies.

Perceived Ease of Use

Perceived ease of use corresponds to users' perception of how simple it is for them to use AR-based technologies for VTO [7]. According to these authors, if perceived by them as user-friendly, they are likely to continue interacting with these technologies in the future.

Perceived Enjoyment

According to authors in [25], perceived enjoyment corresponds to an activity that is likely to provide an enjoyable experience regardless of its outcomes. Moreover, these authors state that in the virtual context, this dimension corresponds to the sense of fun and entertain experienced by AR-based service users, playing an important role in their continuous usage intention.

Behavioural Intentions

Behavioural intentions are “what the person intends to do” [23, p.4], which, according to these authors, refers to users' willingness to engage in specific behaviours associated with a product or a service, such as purchasing a product and revisiting the website or app in the future [23].

Insights from Prior Research

According to the authors in [21], the appliance of AR in a retail environment stimulated consumers’ purchase intention, inducing them not only to make impulse purchases [20], but also to reduce their uncertainties while making their purchases [3]. Due to the fact that through this technology, consumers can explore different product options, try on different looks, receive personalised customisation [25], and get real-time product information [20], authors state that AR ultimately

increased their loyalty, satisfaction [23], and improved their decision-making process [21]. In this context, and according to previous authors, consumers who had a positive perception of a product via the usage of this technology, and perceived a satisfying AR experience [22], were not only more willing to purchase the product [7,22], but also more disposed to recommend the VTO to others, considering its future adoption as well [23]. Additionally, authors in [24] have claimed that consumers expect utilitarian benefits from VTO, which refers to the functional features and usefulness of these technologies [9]. Considering this, the authors affirmed that if consumers perceived AR as being a useful tool for shopping [24] by improving their decision-making process [9], they were more inclined to use it [24]. Furthermore, researchers in [25] indicated that ultimately, AR-based technologies were perceived as useful and easy to use by consumers. Additionally, to these findings, authors in [9] observed that AR positively influenced consumers' hedonic values, meaning that those who perceived AR to be enjoyable and entertaining were more likely to have an higher intention to use it [22].

2.2.2.2 Novel Proposed Dimensions

Ethical and Privacy Concerns

Researchers in [24] proposed that future research should investigate the effects of AR-based systems on users' privacy since corporations might conduct makeup VTO without their permission which could affect their satisfaction. Given this context, we decided to incorporate an additional dimension in our research – Ethical and Privacy Concerns - investigating not only the participants' concerns regarding their privacy but also the ethical issues that may arise from the use of VTO. To properly address this dimension, further literature was investigated, and according to authors in [26] and [27], while AR technology often collects and stores user data, including personal information, without ethical practices, there is a risk of privacy breaches and unauthorised use of personal data, which can lead to serious consequences for individuals' privacy and security. Ultimately, authors in [28] and [29], concluded that privacy concerns negatively influenced AR technology users' usage intention.

VTO Engagement Metrics

Based on previous research [20,23], the authors indicated that retailers could improve their consumers' shopping experience by incorporating AR technology for a more immersive and engaging interaction. According to the authors in [23], engagement refers to the extent of consumers' involvement, interest, and interaction with the technology. In this context, and to have a more comprehensive analysis of how VTO generates consumer engagement, we have decided to incorporate three additional dimensions in our study that have not been addressed in the reviewed literature. These dimensions included: Time Spent on the Platform (i.e., the amount of time participants spent on

the platform), Number of Products Tested (i.e., the number of products that were tested by participants while interacting in the platform), and Variations per Product Tested (i.e., the number of variations within each product that were tested by the participants). Furthermore, these dimensions were assessed a posteriori by having two judges coding the data derived from video recordings, capturing consumers' interactions with the VTO platform that was selected for the experiment.

2.2.2.3 Further Novel Parameters Proposed

Personalised versus non-personalised

The majority of the reviewed studies required participants to use an AR system with their self-image before completing a survey [3,7,9,20,22,23,25]. Although some of the studies also examined the comparison between different groups, such as [25], in which researchers conducted a comparative study between Chinese and South Korean consumers, overall, no literature was found regarding the comparison between the use of personalised (i.e., self-picture) and non-personalised (i.e., model picture) pictures while interacting with the VTO platform. Even though [24] and [21] included a non-personalised picture in their experiment, no prior research has explicitly compared the two conditions we intend to explore (i.e., self-picture vs. model picture).

While in [24], USA and Nicaragua participants were instructed to watch a demonstration video that included a photo of a model before answering a survey, no further comparison was made besides comparing the two countries' participants' perceptions of the VTO through the video visualisation.

Whereas in [21], Korean participants were assigned either to a personalised-AR condition (self-picture) or to a non-personalised AR condition (static picture of the product). The authors found that the personalised-AR condition positively influenced consumers' purchase intention in comparison to those who were only able to see a visual representation of the product itself. These findings provided us with some important insights regarding our methodological approach and expected outcomes. However, in that study, participants were not able to see how the product would look on a model (our intended non-personalised condition).

Within the given literature review, and to the best of our knowledge, we have conducted the first systematic comparison of these two VTO use modalities – participants' self-picture and a model's picture. Moreover, all the reviewed studies were conducted online (i.e., non-laboratorial environment), meaning that researchers did not have control over several contextual features, such as lighting conditions, background noise, the type of equipment used, and the internet connection. In contrast, our study was conducted in a laboratory setting, ensuring a controlled environment to conduct a rigorous experiment.

Chapter 3

Conceptual Framework

3.1 Conceptual Framework

The following conceptual framework in Figure 8, aims to guide the research study's elaboration, offering a visual representation of the assumptions that must be verified to address the stated problem.

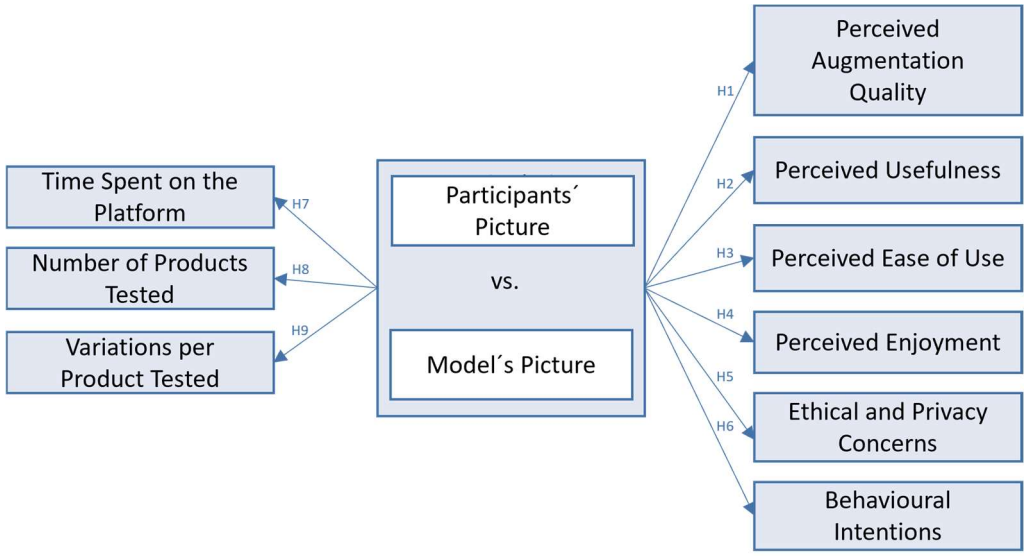


Figure 8 – Conceptual Framework developed by the author.

3.1.1 Variables

3.1.1.1 Independent Variables: VTO use (Participants' Picture vs. Model's Picture).

3.1.1.2 Dependent Variables: Perceived Augmentation Quality; Perceived Usefulness; Perceived Ease of Use; Perceived Enjoyment; Ethical and Privacy Concerns; Behavioural Intentions; Time spent on the platform; Number of products tested, and Variations per Product Tested[5].

[5] "Variations per Product Tested" was computed to examine the relation between the number of products tested and their corresponding variations. The design of this variable was motivated by intrinsic makeup product characteristics. Although some products, such as eye mascara, only display one option to try on, most products display a wide variety of colours and/or textures, particularly in the Lip category. Within this context, a ratio was calculated using the following formula:

$$Variations\ per\ Product\ Tested = Product\ Variations\ Tested / Number\ of\ Products\ Tested \quad (1)$$

3.2 Hypotheses definition

Our study assumed an exploratory nature due to the lack of prior research that compared the usage of VTO with the consumer's picture with a model's picture. Still, the positive outcomes associated with VTO have been observed using self-AR (participants' picture), suggesting a dominant tendency towards personalisation [3,7,9,20,22,23,25]. Furthermore, with [21] suggesting that the personalised-AR condition (self-picture) generated a more positive outcome than the non-personalised AR condition (picture of the product), overall, we expected to observe a more positive impact from the VTO experience when participants were able to use their self-picture, in comparison to those who were instructed to use a model's picture (except for ethical and privacy concerns [28,29]). Specifically, in the participants' picture condition (vs. model's picture condition), we expected to observe higher ratings across evaluative dimensions from their VTO interaction – Perceived Augmentation Quality (H1), Perceived Usefulness (H2), Perceived Ease of Use (H3), Perceived Enjoyment (H4), and Behavioural Intentions to use VTO and make purchases through it (H6). Furthermore, we also anticipated that those who use their picture (versus a model's picture) would spend more time using the VTO platform (H7), try on a higher number of products (H8), and explore a higher number of variations for each product (H9). On the contrary, using the participants' picture may be associated with higher Ethical and Privacy Concerns compared to when they use the model picture (H5).

Chapter 4
Methodology

4.1 Research Approach

The experimental study followed a between-participants design – 2 (VTO use: participants' self-picture vs. model's picture) - and involved the use of both quantitative and qualitative data collection methods to obtain a thorough understanding of consumer experiences, attitudes, and preferences towards VTO use. The measures were assessed in an online survey (hosted in Qualtrics [30]) and presented in Portuguese (Appendix A). Participants were recruited through an institutional panel (SPI – ISCTE [31]) and received partial course credits.

The data was collected during October 2023 at LAPSO-Psychology Laboratory (ISCTE), and while quantitative data was analysed using the SPSS statistical software (V26) [32], the qualitative data was analysed using the MAXQDA software (V22) [33].

4.2 Survey Design

The current research study used a between-subjects experimental design to examine the effects of exposure to a VTO with their personalised picture (self-picture) compared to exposure to a VTO with a non-personalised picture (picture of a model, Appendix B), both shown on the same VTO platform.

A survey was developed (Appendix A), and participants were exposed to the VTO manipulation to conduct a comparative examination of these two distinct scenarios to get a deeper understanding of the possible impacts of using VTO in each instance.

4.3 Procedure

The study involved the recruitment of potential consumers of beauty products to participate in an experiment physically conducted at the ISCTE Psychology laboratory (LAPSO). This experiment's recruitment was limited to first and second-year students enrolled in ISCTE's Psychology or Sociology undergraduate degree courses.

To enrol in this study, two eligibility criteria were established, namely: female gender and Portuguese language speakers. The use of these criteria served to maximise the likelihood of

participants having prior experience with beauty product items and that they were comfortable with the Portuguese language since the survey was designed in this language.

In this context, a total of 80 time slots were made available on the ISCTE Psychology laboratory platform (SONA, [31]) for eligible student enrolment, who were notified of the experiment's availability via email. Upon getting this email notice, they voluntarily enrolled to participate in the experiment, and each participant was then granted partial course credits for their participation. Furthermore, the ISCTE Psychology laboratory platform was configured with 30-minute sessions for each experiment, and accommodated groups of 4 or 5 participants per session. Even though students registered online for all the available openings, 3 of the 80 enrolled students did not show up for their session. As a result, the experiment included the total participation of 77 students, and the collection of data was completed within 3 days.

To ensure participants' privacy and concentration during the experiment, the usage of individual enclosed cubicles in the Psychology laboratory was adopted. Furthermore, to monitor participants' interactions with the VTO platform, OBS image recording software [34] was used in all experimental sessions.

Firstly, at the start of each experiment, the participants were informed that their participation in the study was voluntary, and appropriate measures were taken to safeguard the confidentiality and anonymity of the collected data by signing an informed consent form (Appendix C). On this consent form, they were notified that a picture of themselves could be potentially requested for the experiment.

As previously stated in section 4.2., this experiment used either the participant's picture or a model's picture. Although the VTO platform that was chosen for the experiment offered pre-defined models, we decided to use the Chicago database [35] so we could choose a picture of a model whose features were more representative of our population (e.g., fair skin colour, brunette hair, and brown eye colour) and exhibited an average attractiveness appearance. This decision was made to ensure a more impartial and unbiased experience among participants.

Regarding the participants' picture, we opted to replicate the background of the Chicago database model picture by placing a whiteboard behind each participant. The picture was captured using a mobile phone and then uploaded to a private cloud account that was specifically created for this experiment and was synchronised with each cubicle's computer.

Secondly, the participants were guided to carefully read the instructions (Appendix D) and were exposed to the experiment using M·A·C Cosmetics VTO[6], which was shown to them via the link: www.maccosmetics.com/virtual-try-on and were required to engage in the task of choosing freely

[6] Developed by Perfect Corp [36].

Face, Lips, and/or Eyes makeup categories to try on, while their interactions were being recorded. The purpose of the task was to examine participants' experience with the technology by having them interact with its features, either through the usage of their self-pictures or a model's picture. After the usage of the M·A·C Cosmetics Virtual Try-On, participants were requested to complete a survey (Appendix A).

In the survey, our approach included determining the extent to which participants agreed with several propositions related to their interaction with the chosen VTO platform, including a set of measures (see 4.6. Instruments) that were used and complemented the survey with qualitative questions. Furthermore, participants were requested to provide demographic information regarding their age and income (i.e., 1= "*Far below average*;" 5= "*Far above average*"), as well as their consumption habits, familiarity with the brand, and familiarity with VTO technologies (Appendix E).

4.4 Data Analytics Plan

To analyse the data recorded by the videos, such as the time spent on the platform by the participants, the number of products they tested, and the variations tested for each product, an anonymised ID was associated with each video. The purpose of developing this anonymised ID was to match the survey data with the videos, without disclosing participants' personal information. While watching these videos, the data – ID, time, number of products, and product variations – was manually registered in an Excel spreadsheet and then transferred to SPSS along with the survey data. The qualitative data obtained from the participants' feedback about the main positive and negative aspects of their experience was evaluated and categorised using MAXQDA, which enabled us to conduct a statistical evaluation of the topics that were most frequently cited by the participants.

4.5 Pilot-test

Prior to the experiment's start, an external volunteer from the study was recruited to undertake a pilot test. The purpose of this test was to validate the understandability of the instructions and survey questions. The volunteer used her self-picture for the test and, after we confirmed that everything was comprehensible, the experiment was started.

4.6 Instruments

Constructs and items were included from prior research to guarantee the validity and precision of our study (i.e., Perceived Ease of Use, Perceived Usefulness, Perceived Enjoyment, Behavioural Intentions,

and Perceived Augmentation Quality) were adapted to align with the current study using a 5-point scale, ranging from "*Strongly disagree*" to "*Strongly Agree*" (Table 2). Furthermore, the scales implemented to gather additional data, such as Demographics, participants' Consumption Habits, Familiarity with VTO, and Familiarity with the Brand, varied based on the nature of the questions (Appendix E).

Although all constructs underwent an internal consistency of scale testing and proved to be reliable (Cronbach's Alpha [37] > 0.7), one of the constructs (Perceived Ease of Use) scored slightly below it. Nevertheless, because the value was quite close to the acceptance level (α=0.693), we included it in our study. Furthermore, the items developed to assess Ethical and Privacy Concerns also underwent an internal consistency of scale testing and proved to be also reliable (Spearman-Brown [38] > 0.7), as shown in Table 2.

Table 2 – Constructs, Scales, and Consistency.

Constructs	Original List of Items	Adapted List of Items	Test	Scale Anchors
Perceived Ease of Use [24]	1. The interaction with the AR app is clear and understandable. 2. The interaction with the AR app does not require a lot of mental effort. 3. I find the AR app easy to use. 4. I find it easy to get the AR app to do what I want.	1. The interaction with the VTO is clear and understandable. 2. Interaction with the VTO doesn't require a lot of mental effort. 3. I find the VTO easy to use. 4. I find it easy to get the VTO to do what I want.	0.693	1- "*Strongly disagree*" to 5- "*Strongly agree*".
Perceived Usefulness [39]	1. This ARIT improves my online shopping productivity. 2. This ARIT enhances my effectiveness when shopping online. 3. This ARIT is helpful in buying what I want online. 4. This ARIT improves my online shopping ability.	1. VTO can improve the productivity of my online makeup purchases (e.g., making purchasing decisions or finding product information more quickly). 2. VTO can increase my efficiency when shopping for makeup online (e.g. getting the best deal or finding more information). 3. I think VTO can be useful for buying what I want online. 4. I think VTO can improve my ability to shop for makeup online.	0.823	
Perceived Enjoyment [40]	1. Using VTO was entertaining. 2. Using VTO was enjoyable. 3. Using VTO was fun. 4. Using VTO was exciting.	1. Using the VTO kept me entertained. 2. Using the VTO was enjoyable. 3. Using the VTO was fun. 4. Using the VTO was exciting.	0.812	
Behavioural Intentions [23]	1. I would purchase the product that I evaluated. 2. I would recommend the app to my friends and family. 3. I would return to this app and shop for cosmetic items.	1. I would buy the products I tried with VTO. 2. I would recommend VTO to my friends and family. 3. I would use VTO again to buy makeup products.	0.857	
Perceived Augmentation Quality [20]	1. While using AR app I felt I was actually using the cosmetic product. 2. Using the cosmetic product AR app helped me explore the product effect like in the real world. 3. While using the cosmetic product AR app it seemed that everything that I was seeing on the mobile display was indeed real.	1. When using the VTO, I felt like I was actually using the makeup products. 2. Using the VTO helped me to explore the effect of makeup products as in the real world. 3. While using VTO, it felt like everything I was seeing on the screen was actually real.	0.808	
Ethical and Privacy Concerns (Developed by the author)	n.a.	1. I am concerned about the security of my personal data resulting from the use of VTO. 2. I am concerned that brands using VTO do not follow ethical standards when collecting and using data.	0.823	

Chapter 5

Results Analysis

5.1 Sample Characterisation

A total of 77 survey responses and their corresponding video recordings were included in our study. Nevertheless, upon a rigorous analysis of each participant's interaction video, 2 of the 77 participants were ineligible for inclusion due to their inability to follow the given instructions (i.e., did not use the picture assigned to their condition).

Ultimately, our sample included 75 females, of which 39 who utilised their self-picture (the experimental group), and 36 who used a model's picture (the control group). Participants' ages varied from 17 to 55 years old (M=20, SD=5.74), with the majority being in the 18-20 years old range.

Overall, participants perceived their family income to be in the middle-class range (M=3.11, SD=0.75, $CI_{95\%}$=[2.93, 3.28]), as the mean value did not differ from the scale middle point (t(74)=1.23, p=0.219).

Familiarity with VTO

Participants expressed a relatively low level of familiarity with VTO technologies (M=1.75, SD=1.02, $CI_{95\%}$=[1.51, 1.98]). Additionally, and as illustrated in Figure 9, among those who had prior experience with VTO, its highest reported usage was for Makeup, followed by Hairstyling, Furniture and Interior Design, Glasses, Clothing and/or Footwear, and finally, for Jewellery.

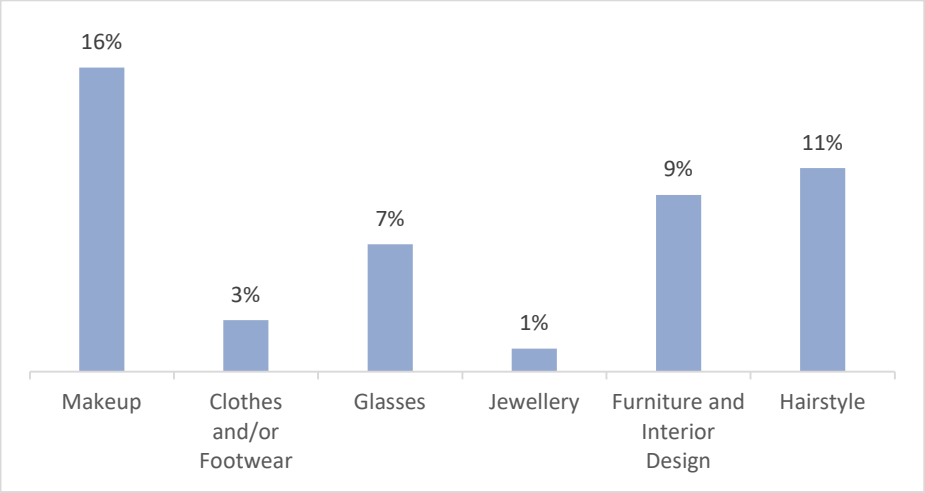


Figure 9 – VTO Prior Experience by Categories

Familiarity with the Brand

Although 62.7% of the participants (*n*=47) reported never having purchased a product from M·A·C Cosmetics, they were moderately familiarised with the brand (*M*=2.96, *SD*=1.47, $CI_{95\%}$=[2.62, 3.30]), and perceived the products as high-quality (*M*=4.08, *SD*=0.78, $CI_{95\%}$=[3.90, 4.26]). Moreover, most participants (96%) were unaware that VTO was available for this brand.

Makeup Consumption Habits

The results of our study indicate that 78.7% of participants (*n*=59) purchased makeup products and expressed a higher interest in acquiring them (*M*=4.08, *SD*=0.95, $CI_{95\%}$=[3.84, 4.33]), in comparison to their real purchasing frequency (*M*=3.12, *SD*=0.95, $CI_{95\%}$=[2.87, 3.37]), ($t(58)= 8.16$, $p < 0.001$). This suggests that even though participants were interested in purchasing makeup products, their effective purchasing action was somehow limited.

Additionally, our study revealed that participants expressed a strong preference to try on makeup products on their skin before purchasing them (*M*=4.24, *SD*=0.94, $CI_{95\%}$=[4.02, 4.46]), meeting their high preference for the traditional In-store purchasing experience (*M*=4.51, *SD*=0.83, $CI_{95\%}$=[4.32, 4.70]).

A repeated-measure ANOVA was applied, showing a significant main effect on beauty product categories (i.e., Eye vs. Lip vs. Face, $F(2,142)=5.87$, $p=0.003$). Specifically, we found that Face products were purchased less often than Eye products (p=0.008). No other pairwise comparisons showed statistically significant differences ($p \geq 0.198$), indicating that consumers' purchase frequency of Lip products was similar when compared to Face and Eye products.

5.2 Results

5.2.1 General Quantitative Data

As presented in Table 3, overall participants perceived VTO as highly easy to use, highly useful, and highly enjoyable. Furthermore, participants expressed a high behavioural intention to use it and purchase makeup products through it. Additionally, participants perceived VTO as having a moderate augmented quality level. Nevertheless, although participants expressed moderate ethical and privacy concerns, there was some variability of opinions among them.

Participants spent on average 8 minutes and 7 seconds on the platform. However, this time widely ranged from 1 minute and 52 seconds to 15 minutes and 50 seconds, indicating some variability among participants' time spent using the VTO platform.

Table 3 – Quantitative Data of the Overall Sample (*n*=75)

	Overall sample (*n*=75)				95% *CI*	
Variables	*M*	*SD*	*min*	*max*	*LB*	*UB*
Perceived Augmented Quality	3.26	0.95	1	5	3.04	3.48
Perceived Usefulness	4.35	0.74	1	5	4.18	4.52
Perceived Ease of Use	4.64	0.46	3	5	4.54	4.75
Perceived Enjoyment	4.19	0.70	1.25	5	4.03	4.35
Ethical and Privacy Concerns	2.85	1.24	1	5	2.56	3.13
Behavioural Intentions	4.04	0.90	1	5	3.83	4.25
Time Spent on the Platform*	8.07	3.42	1.52	15.50	7.28	8.85
Number of Products Tested	5.63	2.71	1	14	5.00	6.25
Variations per Product Tested	4.15	2.35	1	11	3.61	4.69

Note: *Minutes and seconds. *LB* = Lower bound of the 95% Confidence Interval. *UB* = Upper bound of the 95% Confidence Interval.

While interacting with the VTO platform, participants tried on an average of 6 products, which ranged from 1 to 14 products, again indicating the existence of some variability among participants' testing. Furthermore, for each product, participants tried on an average of 4 of its variations. Nevertheless, as those participants tried on from 1 up to 11 variations per product, there was also some variability in participants' product testing.

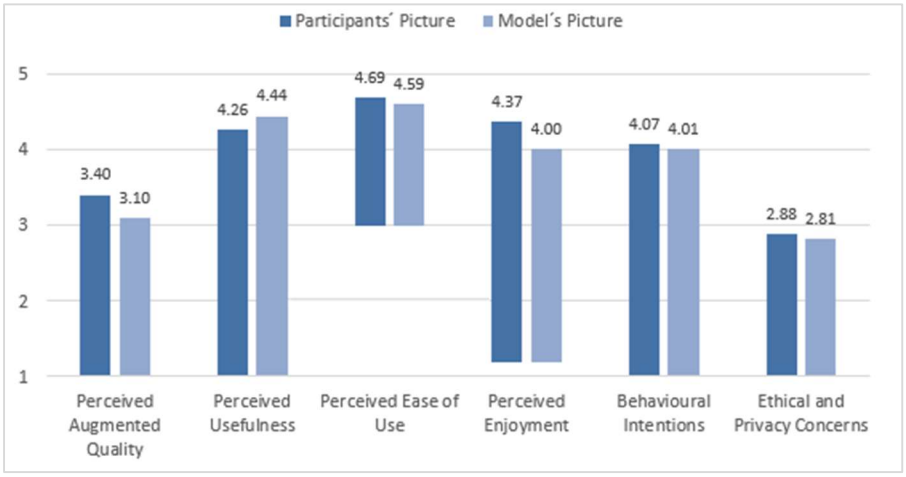


Figure 10 – Means across Evaluative Dimensions according to condition

As illustrated in Figure 10, overall participants perceived the VTO platform in a very positive way, as the mean values from the evaluative dimensions were higher than the midpoint scale (i.e., superior to 3), except for ethical and privacy concerns, which was inferior, indicating that overall, participants were not particularly concerned about these issues. Although the ratings seem slightly higher in the participants' picture condition (except for Perceived Usefulness), the impact of the condition across evaluative dimensions was examined in the next section (5.2.2).

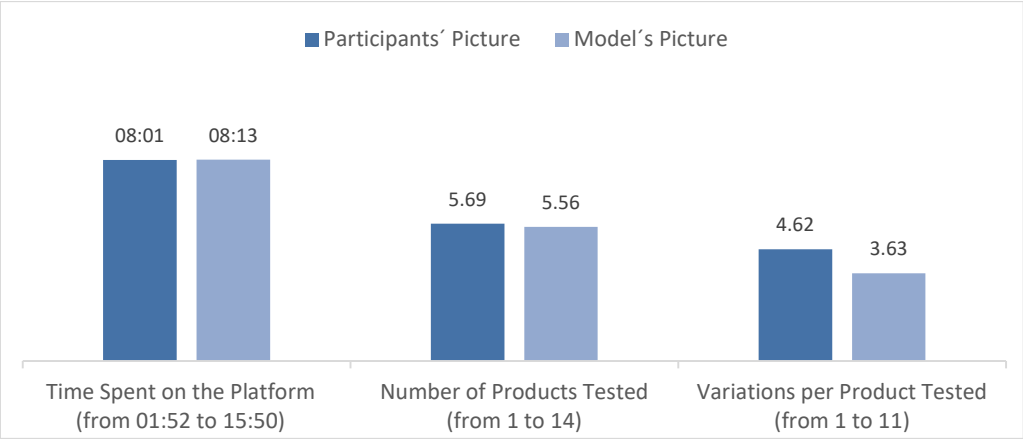


Figure 11 – VTO Engagement Metrics based on their Mean Values

Regarding the quantified engagement metrics collected from the videos, as illustrated in Figure 11, again, the ratings were slightly higher in the participants' picture condition, except for the time spent on the platform. Nevertheless, and as previously stated, further analysis was provided in the following section (5.2.2).

5.2.2 Hypotheses Testing

The data obtained for each of the hypotheses is illustrated in Figure 12, and the respective findings are addressed subsequently.

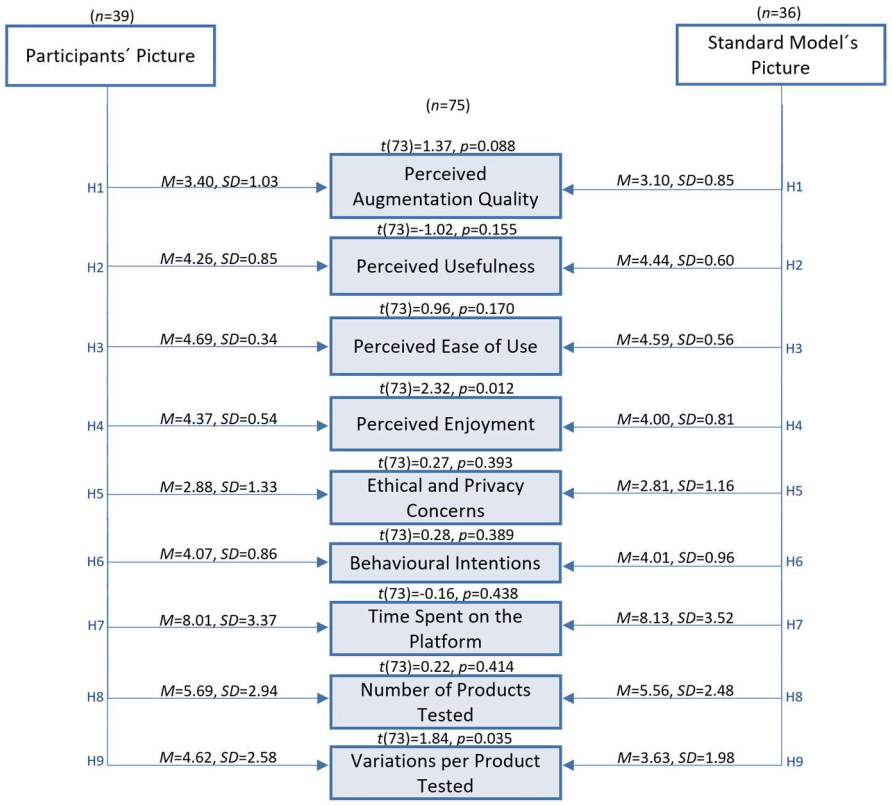


Figure 12 – Illustration of the Results

As shown in Figure 12, overall, we did not observe differences according to experimental condition across the majority of the evaluative dimensions considered. In this context, the expected pattern was only observed for Perceived Enjoyment. Participants who used their self-picture (*M*=4.37, *SD*=0.54), indicated a significantly[7] higher enjoyment level with VTO compared to those who used the model's picture (*M*=4.00, *SD*=0.81), *t*(73)=2.32, *p*=0.023. As a result, the fourth hypothesis was accepted.

Regarding the metrics observed during the VTO experiment, we also did not observe a relevant impact of the picture type used affecting the total Time Spent on the Platform (*t*(73)=-0.16, *p*=0.438), nor did it affect the number of products tested (*t*(73)=0.22, *p*=0.414). Nevertheless, participants who used their self-picture (*M*=4.62, *SD*=2.58) indicated a significantly higher number of Variations per Product Tested using VTO compared to those who used the model's picture (*M*=3.63, *SD*=1.98), *t*(73)=1.84, *p*=0.035. Therefore, the ninth hypothesis was accepted.

5.2.3 Qualitative Analysis

Upon reviewing the qualitative data, and as illustrated in Figure 13, we observed that, overall, participants had a predominantly (67%) positive perception of the VTO experience, while 33% had a negative perception.

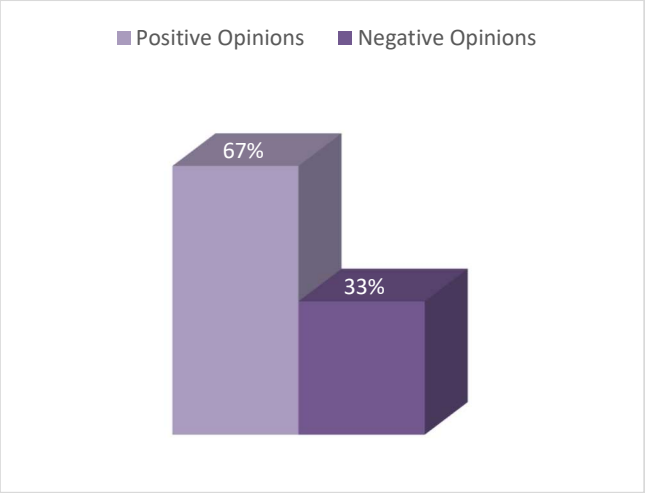


Figure 13 – Participants' Overall Qualitative Perceptions

Moreover, and as illustrated in Figure 14, most of the positive opinions[8] were provided by participants who used their self-picture.

[7] Significant at the 0.05 level

[8] Both positive and negative opinions were counted based on the total number of remarks (i.e., each participant could provide multiple insights for each negative or positive opinion) rather than the total number of participants involved.

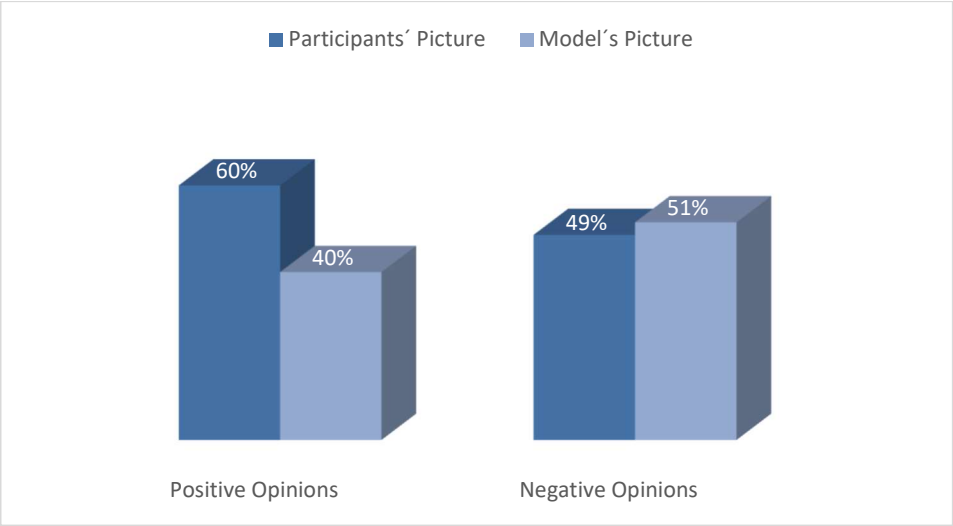


Figure 14 – Participants' Positive and Negative Opinions by Experimental Condition[9]

Negative Opinions[10]

Among all negative opinions, and as seen in Figure 15, the most predominant theme was related to the participants' perception of the VTO's unrealistic effects (36%), followed by the unavailability of the VTO functionality on the website to try on some of the products (25%), its misleading properties for decision-making (11%), and participants' inability to use their self-pictures for the experiment (8%). Although there were further negative opinions which are discussed subsequently, it is important to observe that 7% of the remarks expressed no negative comments regarding their experience with the VTO.

[9] $Absolute\ Percentage = Total\ number\ of\ remarks\ per\ group / Total\ number\ of\ remarks\ among\ all\ participants$ (2)

[10] Based on participants' responses to the question: "What was the most negative aspect about your experience with the Virtual Try-On?"

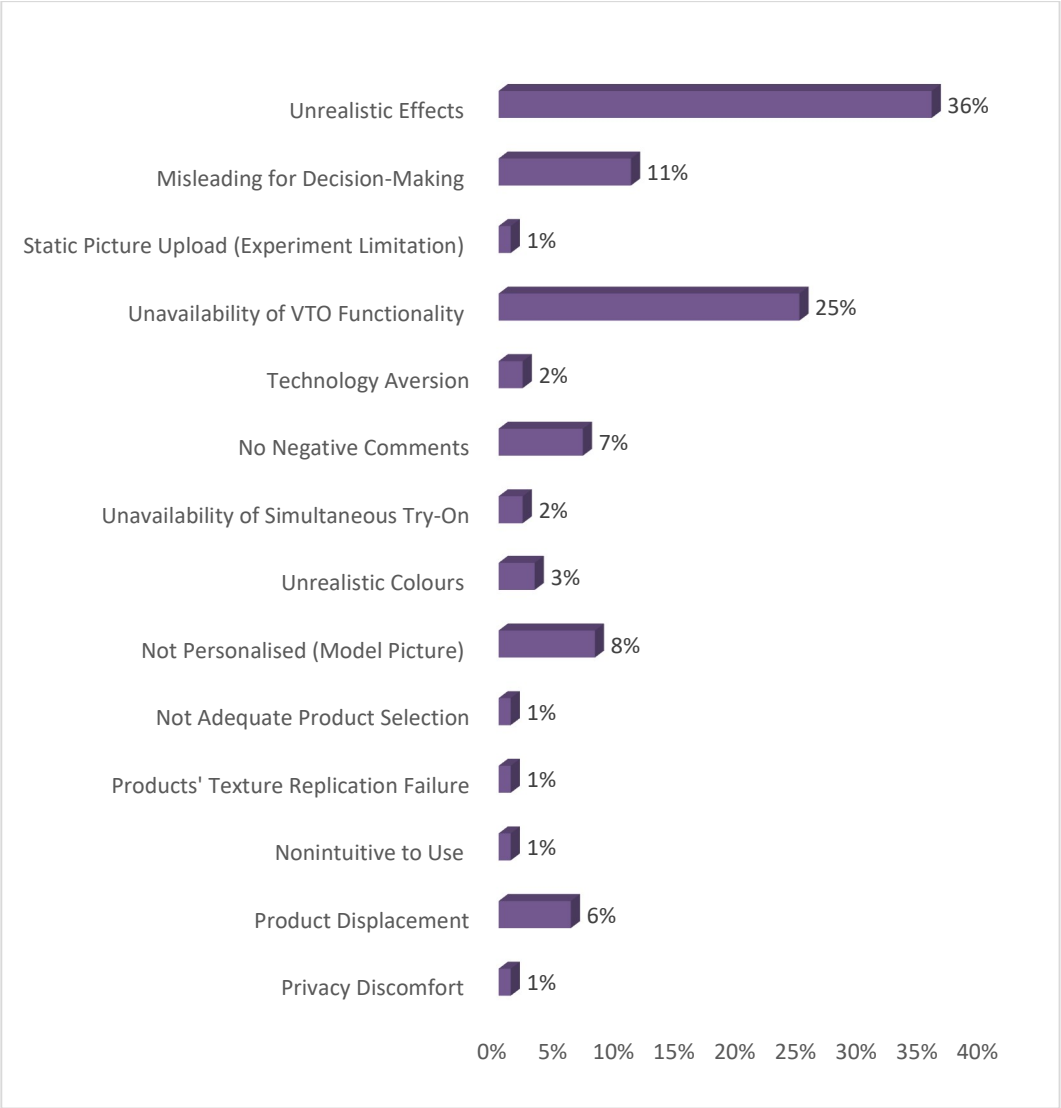


Figure 15 – Participants' Overall Negative Opinions by Themes[11]

While several concepts were common among both groups (i.e., the unrealistic effects of VTO, its misleading properties for decision-making, the absence of VTO functionality on the website, the inability to try on multiple products simultaneously, and the display of unrealistic colours by VTO), there were also exclusive concepts addressed only by each group. Therefore, while they cannot be directly compared, they can provide us additional insights (e.g., participants who used a picture of a model expressed their discontent with their **inability to use their own picture** for the experiment as they were assigned to the control group). For instance, some participants would have preferred to try on the products on themselves (e.g., *"Using a model instead of my own face diminished the enjoyment and kept me from visualising how the product would look on me."; "I found it negative to try on the products on someone else, when I buy them it's for myself so I'd like to have seen them on me."*).

[11] $Absolute\ Percentage = Total\ number\ of\ negative\ remarks\ per\ theme / Total\ number\ of\ negative\ remarks$ (3)

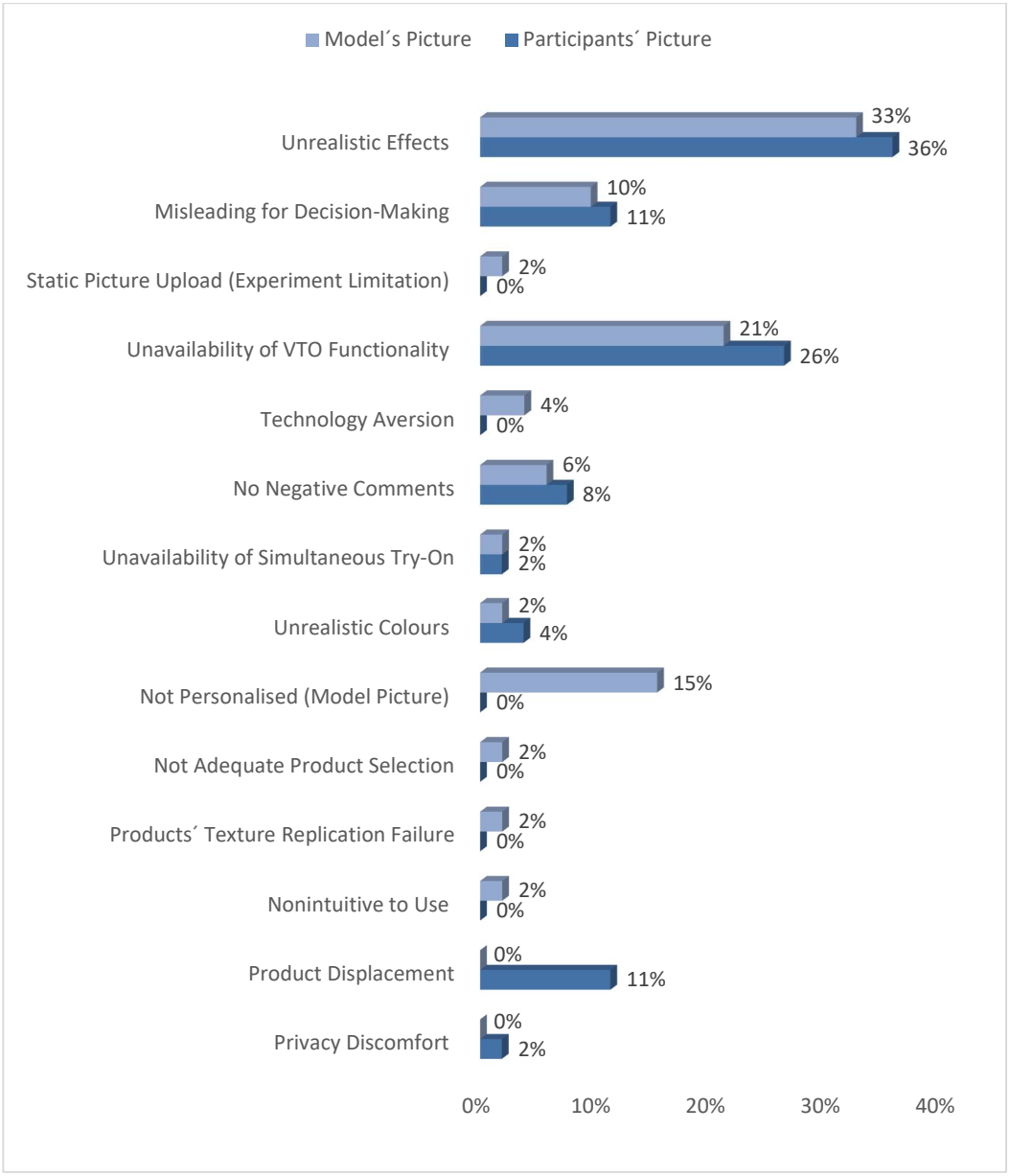


Figure 16 – Participants' Negative Opinions by Themes (by Experimental Condition)

Within this context, and as illustrated in Figure 16, only the group that used the model's picture stated that the **VTO was not intuitive to use** (e.g., *"I did not realise immediately that it was possible to try on the products*"), that the replication of the **product's texture with VTO was not noticeable** (e.g., *"With the highlighter, for example, I didn't notice much difference between the original photo and the one with the product.")*, that the **product selection used in VTO was not suitable for everyday use** (e.g., *"It seems to me to work based on idealised results produced in models that don't correspond to the reality of the product's use by anyone in their daily lives."*) and they also referred to the limitation of the experiment, which **only allowed the downloading of a picture** (e.g., *"As we only download a photo of ourselves, we are given a more static and not so natural idea of how the product might look*

on us"). Furthermore, they referred to a certain **aversion towards the technology** (e.g., "The most negative point was not to try it directly on my skin and see the reactions and how it looks on my skin").

Nevertheless, only the group that used their self-picture stated **privacy discomfort** over the use of their own image (e.g., *"Downloading a photo of myself is uncomfortable.")* and perceived **VTO's product displacement** (e.g., *"The lip products did not fit my lips precisely"*; *"The eyebrows are not quite perfect yet"; "The same product changed position on my face when the colour of the product changed.*")

When participants shared the same concepts, we observed that those who used their self-picture for the experiment expressed a higher dissatisfaction regarding the **unrealistic effects of VTO** (e.g., *"Some products, such as eyelash mascara and eye shadow, are a little unrealistic")*, in comparison to the participants who used the picture of a model *(*e.g., *"The eyeshadows are not very realistic"*). Furthermore, those who used their self-picture noticed greater **unavailability of the VTO functionality** (e.g., "*Of the foundations I selected, none were available for trying on, which I think is usually one of the most difficult products to understand whether it looks good or not*") and perceived it to be slightly more **misleading for decision-making** (e.g., " *Not all of the products seemed very realistic to me, which could have made me a little reluctant in the buying process"*). Additionally, they also thought that the **colours displayed by the VTO were more unrealistic** (e.g., *"Especially those with stronger tones, looked strange")*, and provided more **no negative comments** feedback (e.g., *"I have nothing negative to say"*).

Furthermore, both groups of participants expressed the same percentage of those who indicated that they were **not able to try on multiple products at the same time** (e.g., *"I did not like the fact that we can't test several products at the same time to get an idea of how they go together").*

Positive Opinions[12]

Within the positive opinions, as illustrated in Figure 17, the most predominant theme was related to the participants' personalisation perception (40%), and the general try-on functionality (33%). A smaller percentage of participants expressed positive perceptions regarding the VTO realistic effects (13%), and its part in facilitating decision-making (10%). In addition, other positive opinions included the possibility of previewing the product colours through VTO (6%), the convenience of using the VTO (6%), and the realistic representation of colours (5%). Furthermore, a residual percentage found it as a purchase process facilitator, useful, fun, and easy to use.

[12] Based on participants' responses to the question: "What was the most positive aspect about your experience with the Virtual Try-On?"

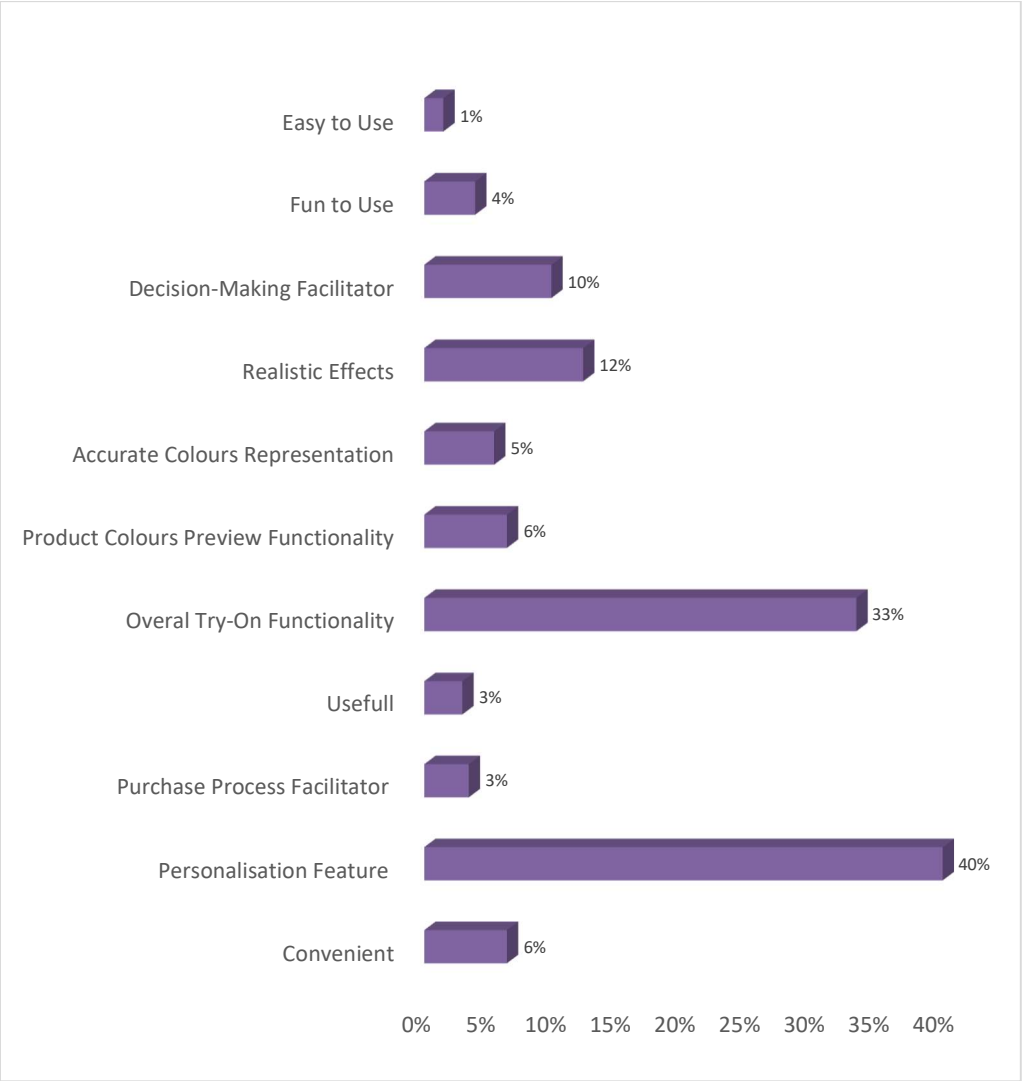


Figure 17 – Participants' Overall Positive Opinions by Themes[13]

While we found that all the concepts were mutual between both groups, as seen in Figure 18, those who used their self-pictures expressed higher satisfaction with their **personalised experience** (e.g., *"I liked being able to see which shades of makeup suit me best"*) compared to the group that used a picture of a model (e.g., "the *VTO somehow made it possible to understand how the eyeshadows would look"*). Furthermore, those who used their picture in the experiment reported that they found VTO to be more **useful** (e.g., *"Especially when it comes to lipsticks, I found this tool very useful"*), more facilitating of their **purchasing process** (e.g., "It *seems to me to be very useful for shopping online or even trying out certain products without feeling pressured to buy*"), and more **convenient** (e.g., "I *liked the fact that I didn't have to use all the products I wanted to try, take them off and continue the process ten times*") when compared to the control group. In addition, the experimental group reported that

[13] $Absolute\ Percentage = Total\ number\ of\ positive\ remarks\ per\ theme / Total\ number\ of\ positive\ \ remarks$ (4)

VTO facilitated more their **decision-making** (e.g., "I *think it helps to make some decisions about the purchase, namely the tone of the product"*), in comparison to the control group.

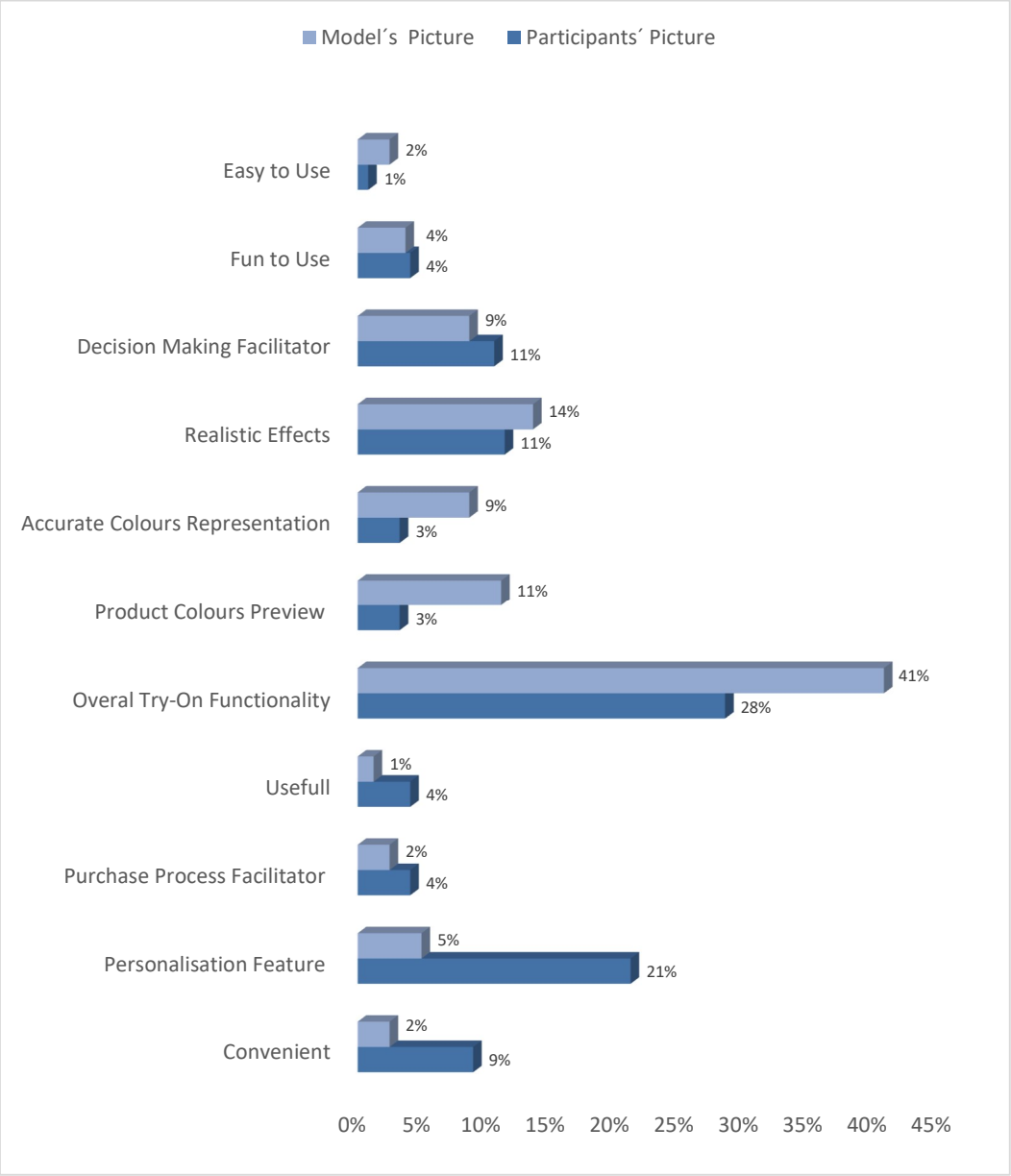


Figure 18 – Participants' Positive Opinions by Themes (by Experimental Condition)

Nevertheless, participants who used a picture of a model proportionally referred more positively to the **overall try-on functionality** provided by the VTO (e.g., "I *liked being able to try the products on a face"*) compared to the experimental group (e.g., "I *enjoyed being able to try on different types of makeup"*). Furthermore, the group that used the picture of the model also found VTO to have a more **realistic effect**, (e.g., *"(…) being able to see how the products would look when used"*), highlighted the VTO **colour preview functionality** (e.g., *"Often, when I buy makeup online, it's hard to get a sense of the real colour of a certain product"*), and its **realistic colours** (e.g., *"I thought that in the lipsticks the*

colour looked very realistic and you could get an idea of what they would look like."), and found it to be slightly **easier to use** (e.g., "I *found it easy to choose the colours that I thought looked best on the model"*) in comparison to the experimental group.

Finally, when asked about the most positive aspect of the VTO experience, both groups of participants indicated the same proportion of opinions regarding being **fun to use** (e.g., "It *was fun to see how I looked with certain makeup products"; It was a lot of fun to get a better idea of the shades and colours available for each product, and the changes they make to the model's face"*).

5.2.4 Further Analysis

By analysing the correlations between the quantitative variables, and as shown in Figure 19, we obtained further insights into our research study. In this context, we observed positive associations between the assessed variables. Specifically, Behavioural Intentions (BI) was strongly correlated [41] with: Perceived Augmented Quality (PAQ), moderately with the Perceived Usefulness (PU) and the Perceived Enjoyment (PE), and weakly with the Perceived Ease of Use (PEU).

Moreover, PAQ had a positive, equivalent, and moderate correlation with both PU and PE and a positive and weaker correlation with PEU. In addition, PE has shown a positive and moderate correlation with PEU.

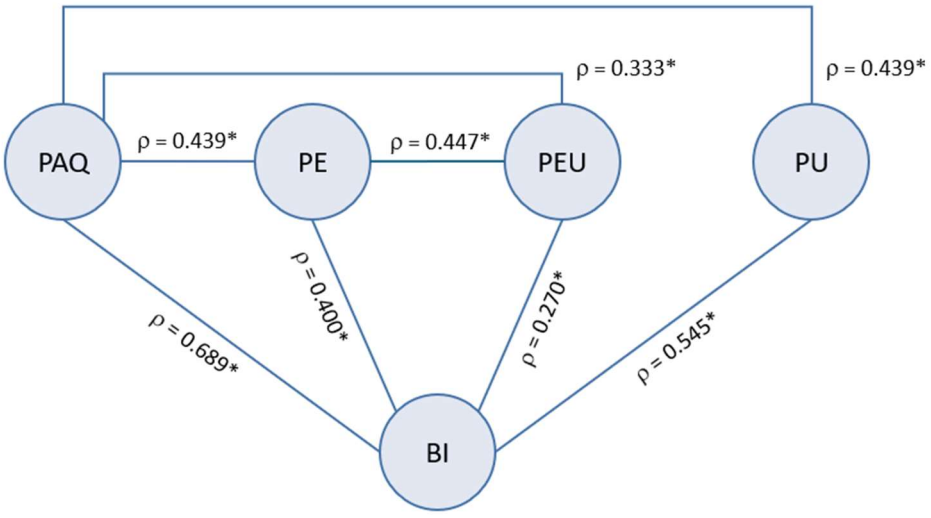


Figure 19 – Correlations

Note: * Correlation significant at the 0.01 level

Chapter 6
Discussion and Conclusions

In the current work, we investigated the multifaceted area of VTO technologies within the context of the beauty industry, specifically focusing on makeup application. The purpose of our research was to gain insight into consumers' perceptions of VTO technologies, by examining the impact of these technologies on their usage and purchase intentions, as well as identifying the main challenges encountered by them when interacting with the VTO platform. In this context, we conducted a comprehensive investigation, assessing both quantitative and qualitative data to determine to which extent participants' perceptions of VTO were influenced by using a personalised picture (self-picture) compared to a non-personalised picture (model's picture). The relevance of our research resides in its alignment with the evolving e-commerce landscape of the beauty industry, and the increasing adoption of online platforms by consumers, where VTO technologies are undertaking an increasingly important relevance in the digital environment.

6.1 General Discussion and Conclusions

While the M·A·C Cosmetics VTO platform was generally perceived positively by the participants, our findings revealed varying perceptions across the assessed quantitative dimensions (Appendix F), with some of them being perceived more positively than others, which has shown to be partially aligned with the qualitative data that was collected.

In response to the research question: **"What is the impact of virtual makeup try-on technologies on consumers' usage and purchase intentions?" –** The literature review suggests that the high ratings obtained in our research across the quantitative dimensions PEU, PU, PE, and BI, (in descending order), along with the lower concerns about privacy and ethics, indicate that participants would be more inclined to use it (i.e., the easier VTO was to use [7], the more enjoyable [25], the more useful [24], and the less privacy concerns there were [28,29], the more participants would want to use it). Although no significant differences were found between the groups of participants in most of the quantitative dimensions, those who used their personalised picture expressed significantly higher levels of enjoyment during the experiment and showed more interest in testing more product variations. These findings contribute to our understanding of the importance of personalisation in VTO as a means to improve its usage intention among consumers. Nevertheless, considering the qualitative opinions and the moderate rating for the PAQ dimension, indicated that consumers perceived an existing inaccuracy

in the virtual representation of the products, leading them to feed the opinion that VTO was misleading for their decision-making process, which could negatively influence their intentions to use it [20]. While no significant difference was found among the groups of participants concerning the PAQ dimension, the analysis of the qualitative data emphasised this characteristic as the most negative aspect pointed out by those who used their personalised picture. Moreover, despite the strong and positive correlation observed between the PAQ and the BI dimensions (suggesting that consumers' intentions to use and purchase through VTO could be positively impacted by its technical quality), it is important to recognise the potential implicit influence of other factors on this relationship. Therefore, further investigation should be taken to conclusively establish unequivocal causation.

In response to the research question: **"Which key challenges do consumers face when using VTO technologies?" –** The main significant challenge reported by participants in our qualitative study was the VTO's unrealistic effects, particularly when using their personalised picture in the experiment. This diagnosed challenge included the inaccuracy in the simulation of the appearance of the makeup products, (such as their colours and textures) which could result in the VTO being considered misleading and negatively impacting the participants' decision-making process to make the purchase. Moreover, from the reported product displacement, we conclude that the VTO had not yet been fully optimised to accurately place the virtual elements into the human face. Aligned with this, the moderate ratings obtained from the quantitative PAQ dimension, indicated again, that consumers may have faced challenges in perceiving VTO as realistic.

Furthermore, a considerable percentage of participants expressed their dissatisfaction regarding the limited range of products that were available on the VTO platform. This indicated us a constraint for those who were seeking to explore a wider range of colours or product categories, particularly by those who used their personalised picture in the experiment. Nevertheless, although participants in our study considered this as a challenge, it is important to note that we cannot assure that these limitations on product availability were due to the VTO technology itself or if it had not yet been configured in the M·A·C Cosmetics VTO platform.

Additionally, especially when using the picture of the model, participants emphasised the importance of personalisation, (i.e., expressed the need for personalisation) which should be taken into consideration when it comes to ensuring that this functionality is made available to consumers.

In conclusion, while our research revealed that both groups of participants had an overall positive perception of VTO, no significant differences were found among the majority of the quantitative measures, except for two of them (Perceived Enjoyment and Variations per Product Tested). This suggests that the impact of the type of picture used in this VTO experiment might be weaker than expected. Nevertheless, the diagnosed technical limitations and the need for a more personalised experience (as stated even by those using their picture in the experiment) provided us with important

insights for guiding beauty industry stakeholders on how to align their e-commerce strategies with their consumers' expectations.

6.2 Limitations and Future Work

Although this study has provided us with important findings that complemented the insights from prior research, it is crucial to acknowledge its inherent limitations. Firstly, although the laboratory setting increased the internal validity of our study, (i.e., most aspects were controlled), it also reduced the external and ecological validity. To overcome these limitations, we recommend that future research replicate the study under more natural conditions, by incorporating a more diverse population in terms of age, gender, and culture (our sample only included ISCTE students, who identified as female gender and Portuguese speakers) and, by increasing the sample size (which in our case was small, *n*=75). In this context, and by incorporating these suggestions in future studies, researchers will be able to provide more robust and enriched conclusions than ours by including a larger and more representative sample of consumer perceptions.

Secondly, as the study followed a cross-sectional research design, we were only able to analyse consumers' perceptions within a limited short period of time (our data was collected within 3 days). In this sense, by conducting a longitudinal study, future researchers will be able to understand the long-term impacts of VTO on consumers' perceptions, hence having a more comprehensive analysis over the researched theme.

Thirdly, the information collected in the survey regarding the characterisation of the sample (consumption habits, familiarity with VTO technologies, and familiarity with the brand), could have been used as control variables, and therefore a more comprehensive analysis over the relationship between these topics and consumers' perceptions could have been investigated. In this context, we suggest that future research include these metrics for a more profound analysis.

Fourthly, our analysis was somewhat limited since we exclusively used a single VTO platform (offered by M·A·C Cosmetics), not considering other alternative VTO platforms available in the market (such as the one offered by L'Oréal). By incorporating other VTO platforms into future studies, researchers could possibly provide additional insights regarding consumers' perceptions.

Fifthly, our research was limited to the use of a single type of device – a computer – which may not have been representative of the evolving trends that have emerged in recent years (the increasing adoption of mobile phones [42]). Consequently, future research may consider exploring alternative devices, such as mobile phones, to provide a more practical perception of consumers over these technologies.

Sixthly, while our study incorporated both personalised and non-personalised human facial pictures in the experiment, we did not entirely explore the immersive functionalities of the VTO platform, specifically its real-time camera feature. In this context, future research can examine how consumers perceive VTO technologies when their maximum capabilities are considered.

Seventhly, as our study only focused on specific dimensions, future research could include additional dimensions to provide a more comprehensive analysis regarding this research topic.

Finally, it is important to emphasise that as our study focused exclusively on the makeup category within the beauty industry, some caution should be taken when extrapolating our findings to other industries.

6.3 Recommendations for Stakeholders

Retailers and technology providers should invest in research and development of VTO's features, not only to address the current challenges identified by this study, but also to anticipate and address new challenges that may emerge over time. By guaranteeing the continuous optimisation of VTO technologies given the existing functionalities and the integration of new ones, (such as the possibility to try on simultaneous products at the same time) by enhancing VTO's technical qualities, (such as VTO's realism and accuracy) retailers can increase their consumers' satisfaction, and consequently boost their business sales. Moreover, prioritising personalisation over non-personalisation, which has shown to significantly impact consumer enjoyment and engagement while interacting with the VTO platform, should serve as a relevant indicator for the interested parties to meet their consumer expectations. Additionally, our study suggests that expanding the range of products available for VTO is also recommended. By allowing consumers to have a more extensive selection of products to try on, their frustrations regarding this limitation can be minimised.

Although we found that participants' concerns with privacy and ethics were minimal in our study, guaranteeing those requirements among consumers over the long term is crucial for maintaining their confidence in these technologies. Furthermore, even though we found that participants were familiar with the brand, the majority were not aware of its VTO, hence indicating the necessity of implementing marketing strategies to promote awareness regarding VTO, not only to inform existing retailers' consumers but also to attract potential new ones.

References

[1] O. Y. Oumeish, "The cultural and philosophical concepts of cosmetics in beauty and art through the medical history of mankind," *Clinics in Dermatology*, vol. 19, no. 4, pp. 375–386, Jul. 2001, doi: 10.1016/S0738-081X(01)00194-8.

[2] Malekpour, M., "Disruptions in Iranian Beauty Retail through Digital Transformation .," *ESIC Digital Economy and Innovation Journal*, 2022. [Online]. Available: https://doi.org/10.55234/edeij-1-2-052

[3] Y. Wang, E. Ko, and H. Wang, "Augmented reality (AR) app use in the beauty product industry and consumer purchase intention," *Asia Pacific Journal of Marketing and Logistics*, vol. 34, no. 1, pp. 110–131, 2022, doi: 10.1108/APJML-11-2019-0684.

[4] A. D. F. S. Borges and C. H. Morimoto, "A virtual makeup augmented reality system," presented at the Proceedings - 2019 21st Symposium on Virtual and Augmented Reality, SVR 2019, 2019, pp. 34–42. doi: 10.1109/SVR.2019.00022.

[5] "M·A·C." Accessed: Jan. 21, 2024. [Online]. Available: https://www.elcompanies.com/en/our-brands/mac

[6] F. Bonetti, G. Warnaby, and L. Quinn, "Augmented Reality and Virtual Reality in Physical and Online Retailing: A Review, Synthesis and Research Agenda," in *Augmented Reality and Virtual Reality*, Springer, Cham, 2018, pp. 119–132. doi: 10.1007/978-3-319-64027-3_9.

[7] S. Bialkova and C. Barr, "Virtual Try-On: How to Enhance Consumer Experience?," presented at the Proceedings - 2022 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops, VRW 2022, 2022, pp. 253–260. doi: 10.1109/VRW55335.2022.00059.

[8] "The State of Fashion: Beauty." [Online]. Available: https://www.mckinsey.com/industries/retail/our-insights/the-beauty-market-in-2023-a-special-state-of-fashion-report

[9] S. H.-Y. Hsu, H.-T. Tsou, and J.-S. Chen, "'Yes, we do. Why not use augmented reality?' customer responses to experiential presentations of AR-based applications," *Journal of Retailing and Consumer Services*, vol. 62, 2021, doi: 10.1016/j.jretconser.2021.102649.

[10] J. Tseng and H. Tzou, "How AI and AR can help beauty industry," 2022.

[11] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, "Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement," *BMJ (Online)*, vol. 339, no. 7716, pp. 332–336, 2009, doi: 10.1136/bmj.b2535.

[12] "Zotero | Your personal research assistant." Accessed: Dec. 10, 2023. [Online]. Available: https://www.zotero.org/

[13] "ModiFace - Augmented Reality." Accessed: Jan. 29, 2024. [Online]. Available: https://modiface.com/our-technology.html#tracking

[14] M. I. Jordan and T. M. Mitchell, "Machine learning: Trends, perspectives, and prospects," *Science*, vol. 349, no. 6245, pp. 255–260, Jul. 2015, doi: 10.1126/science.aaa8415.

[15] "L'Oréal's market share worldwide by region 2022," Statista. Accessed: Jan. 22, 2024. [Online]. Available: https://www.statista.com/statistics/243955/market-share-of-loreal-by-region/

[16] "L'Oréal acquires ModiFace further expanding its worldwide expertise in beauty tech," L'Oréal Finance. Accessed: Jan. 22, 2024. [Online]. Available: https://www.loreal-finance.com/eng/news-release/loreal-acquires-modiface-further-expanding-its-worldwide-expertise-beauty-tech

[17] "Discover Modiface," Flowplayer. Accessed: Jan. 22, 2024. [Online]. Available: https://ljsp.lwcdn.com/api/video/embed.jsp?id=cee639c0-1b44-40d6-b52a-59cca3d7242b&pi=9d279982-92df-4403-9e32-aa67212a16c0&source=facebook

[18] P. Corp, "Perfect Corp. Partners with M·A·C Cosmetics and SoPost for a First-to-Market Personalized Product Sampling Experience | PERFECT." Accessed: Jan. 22, 2024. [Online]. Available: https://www.perfectcorp.com/business/news/detail/1941

[19] "Net sales of Estée Lauder worldwide 2008-2023," Statista. Accessed: Jan. 22, 2024. [Online]. Available: https://www.statista.com/statistics/267936/net-sales-of-estee-lauder-worldwide/

[20] J. Trivedi, D. Kasilingam, P. Arora, and S. Soni, "The effect of augmented reality in mobile applications on consumers' online impulse purchase intention: The mediating role of perceived value," *Journal of Consumer Behaviour*, vol. 21, no. 4, pp. 896–908, 2022, doi: 10.1002/cb.2047.
[21] J. Whang, J. Song, B. Choi, and J. Lee, "The effect of Augmented Reality on purchase intention of beauty products: The roles of consumers' control, *"Journal of Business Research*, vol. 133, pp. 275–284, Sep. 2021, doi: 10.1016/j.jbusres.2021.04.057.
[22] M. Oyman, D. Bal, and S. Ozer, "Extending the technology acceptance model to explain how perceived augmented reality affects consumers' perceptions," *Computers in Human Behavior*, vol. 128, 2022, doi: 10.1016/j.chb.2021.107127.
[23] M. Park and J. Yoo, "Effects of perceived interactivity of augmented reality on consumer responses: A mental imagery perspective," *Journal of Retailing and Consumer Services*, vol. 52, 2020, doi: 10.1016/j.jretconser.2019.101912.
[24] S. Castillo and E. Bigne, "A model of adoption of AR-based self-service technologies: a two country comparison," *International Journal of Retail & Distribution Management*, vol. 49, no. 7, pp. 875–898, Jul. 2021, doi: 10.1108/IJRDM-09-2020-0380.
[25] A. Butt, H. Ahmad, A. Muzaffar, F. Ali, and N. Shafique, "WOW, the make-up AR app is impressive: a comparative study between China and South Korea," *Journal of Services Marketing*, vol. 36, no. 1, pp. 73–88, 2022, doi: 10.1108/JSM-12-2020-0508.
[26] P. Steele, C. Burleigh, M. Kroposki, M. Magabo, and L. Bailey, "Ethical Considerations in Designing Virtual and Augmented Reality Products—Virtual and Augmented Reality Design With Students in Mind: Designers' Perceptions," *Journal of Educational Technology Systems*, vol. 49, no. 2, pp. 219–238, Dec. 2020, doi: 10.1177/0047239520933858.
[27] S. Bindahman, N. Zakaria, and N. Zakaria, "3D body scanning technology: Privacy and ethical issues," in *Proceedings Title: 2012 International Conference on Cyber Security, Cyber Warfare and Digital Forensic (CyberSec)*, Kuala Lumpur, Malaysia: IEEE, Jun. 2012, pp. 150–154. doi: 10.1109/CyberSec.2012.6246113.
[28] S. Youn, J. Hwang, L. Zhao, and J.-B. Kim, "Privacy paradox in 3D body scanning technology: the effect of 3D virtual try-on experience in the relationship between privacy concerns and mobile app adoption intention," *Humanit Soc Sci Commun*, vol. 10, no. 1, Art. no. 1, Apr. 2023, doi: 10.1057/s41599-023-01632-y.
[29] "Privacy concerns when using augmented reality face filters? Explaining why and when use avoidance occurs — University of Bristol." Accessed: Dec. 19, 2023. [Online]. Available: https://research-information.bris.ac.uk/en/publications/privacy-concerns-when-using-augmented-reality-face-filters-explai
[30] "Experience management in a single piece of software - Qualtrics," Qualtrics - PT BR. Accessed: Dec. 19, 2023. [Online]. Available: https://www.qualtrics.com/pt-br/
[31] "SPI - Sistema de Participação em Investigação em Psicologia." Accessed: Dec. 19, 2023. [Online]. Available: https://iscte-iul.sona-systems.com
[32] "SPSS Software | IBM." Accessed: Dec. 19, 2023. [Online]. Available: https://www.ibm.com/spss
[33] "MAXQDA | All-In-One Qualitative & Mixed Methods Data Analysis Tool," MAXQDA. Accessed: Dec. 19, 2023. [Online]. Available: https://www.maxqda.com/
[34] "Open Broadcaster Software | OBS." Accessed: Dec. 19, 2023. [Online]. Available: https://obsproject.com/
[35] "CFD | Chicago Face Database." Accessed: Dec. 19, 2023. [Online]. Available: https://www.chicagofaces.org/
[36] P. Corp, "AI & AR Business Solutions for Skin, Beauty & Fashion." Accessed: Dec. 19, 2023. [Online]. Available: https://www.perfectcorp.com/business
[37] R. Toro, M. Peña-Sarmiento, B. L. Avendaño-Prieto, S. Mejía-Vélez, and A. Bernal-Torres, "Empirical Analysis of Cronbach's Alpha Coefficient as a Function of Question Response Options, Sample Size and Outliers," *Revista Iberoamericana de Diagnostico y Evaluacion Psicologica*, vol. 63, no. 2, pp. 17–30, 2022, doi: 10.21865/RIDEP63.2.02.

[38] J. L. Ellis, “The Spearman-Brown Formula and Reliabilities of Random Test Forms,” 2023, doi: 10.48550/ARXIV.2308.13811.
[39] T.-L. Huang and S. Liao, “A model of acceptance of augmented-reality interactive technology: the moderating role of cognitive innovativeness,” *Electron Commer Res*, vol. 15, no. 2, pp. 269–295, Jun. 2015, doi: 10.1007/s10660-014-9163-2.
[40] A. Morabet, “Beauty Fitting Rooms: The Impact of Virtual Try-On Consumers´ Attitudes and Behavioural Intentions”.
[41] *Straightforward Statistics for the Behavioral Sciences*. Accessed: Jan. 22, 2024. [Online]. Available: https://books.google.com/books/about/Straightforward_Statistics_for_the_Behav.html?hl=pt-PT&id=8Ca2AAAAIAAJ
[42] “Digital 2023: Global Overview Report,” DataReportal – Global Digital Insights. Accessed: Jan. 21, 2024. [Online]. Available: https://datareportal.com/reports/digital-2023-global-overview-report

Appendices

Appendix A - Qualtrics Survey

Incio do bloco: Código Participante

P0 Escreva o seu código de participante indicado pelo investigador.

_____

Fim do bloco: Código Participante

Início do bloco: texto inicial

Olá Bem vinda e muito obrigada pela sua colaboração.

Pedimos que responda de seguida a algumas questões em relação à sua experiência de interação com o Virtual Try-On (VTO), bem como a outras questões adicionais que consideramos relevantes para o nosso estudo.

Tempo estimado para conclusão: 10 minutos.

Vamos começar! :)

Fim do bloco: texto inicial

Início do bloco: Facilidade de Uso Percebida

P1 Selecione a resposta que mais se adeque à sua perceção de facilidade de uso do Virtual Try-On (VTO).

	Discordo totalmente (1)	Discordo parcialmente (2)	Nem concordo nem discordo (3)	Concordo parcialmente (4)	Concordo totalmente (5)
A interação com o VTO é clara e compreensível. (1)	○	○	○	○	○
A interação com o VTO não exige muito esforço mental. (2)	○	○	○	○	○
Considero o VTO fácil de utilizar. (3)	○	○	○	○	○
Considero fácil conseguir que o VTO faça o que eu quero. (4)	○	○	○	○	○

Fim do bloco: Facilidade de Uso Percebida

Início do bloco: Utilidade Percebida

P2 Selecione a resposta que mais se adeque à sua perceção de utilidade do Virtual Try-On (VTO).

	Discordo totalmente (1)	Discordo parcialmente (2)	Nem concordo nem discordo (3)	Concordo parcialmente (4)	Concordo totalmente (5)
O VTO pode melhorar a produtividade das minhas compras de maquilhagem online. (ex: tomar decisões de compra) (1)	○	○	○	○	○
O VTO pode aumentar a minha eficácia quando efetuar compras de maquilhagem online. (ex: encontrar um maior número de informações) (2)	○	○	○	○	○
Considero que o VTO pode ser útil para comprar o que quero online. (3)	○	○	○	○	○
Considero que o VTO pode melhorar a minha capacidade de poder efetuar compras de maquilhagem online. (4)	○	○	○	○	○

Fim do bloco: Utilidade Percebida

Início do bloco: Diversão Percebida

P3 Selecione a resposta que mais se adeque à sua perceção de diversão com o Virtual Try-On (VTO).

	Discordo totalmente (1)	Discordo parcialmente (2)	Nem concordo nem discordo (3)	Concordo parcialmente (4)	Concordo totalmente (5)
A utilização do VTO manteve-me entretida. (1)	○	○	○	○	○
A utilização do VTO foi agradável. (2)	○	○	○	○	○
A utilização do VTO foi divertida. (3)	○	○	○	○	○
Utilizar o VTO foi emocionante. (4)	○	○	○	○	○

Fim do bloco: Diversão Percebida

Início do bloco: Qualidade AR Percebida

P4 Selecione a resposta que melhor descreve a sua perceção de qualidade do Virtual Try-On (VTO).

	Discordo totalmente (1)	Discordo parcialmente (2)	Nem concordo nem discordo (3)	Concordo parcialmente (4)	Concordo totalmente (5)
Ao utilizar o VTO, senti que estava realmente a utilizar os produtos de maquilhagem. (1)	○	○	○	○	○
A utilização do VTO ajudou-me a explorar o efeito dos produtos de maquilhagem como no mundo real. (2)	○	○	○	○	○
Enquanto utilizava o VTO, parecia que tudo o que estava a ver no ecrã era de facto real. (3)	○	○	○	○	○

Fim do bloco: Qualidade AR Percebida

Início do bloco: Intenção Comportamental de Uso

P5 Selecione a opção que melhor caracteriza o seu comportamento futuro após a interação com o Virtual Try-On (VTO).

	Discordo totalmente (1)	Discordo parcialmente (2)	Nem concordo nem discordo (3)	Concordo parcialmente (4)	Concordo totalmente (5)
Compraria os produtos que experimentei com o VTO. (1)	○	○	○	○	○
Recomendaria o VTO aos meus amigos e familiares. (2)	○	○	○	○	○
Voltaria a usar o VTO para comprar produtos de maquilhagem. (3)	○	○	○	○	○

Fim do bloco: Intenção Comportamental de Uso

Início do bloco: Ética e Privacidade

P6 Responda às seguintes afirmações de acordo com a sua opinião em relação a Virtual Try-On.

	Discordo totalmente (1)	Discordo parcialmente (2)	Nem concordo nem discordo (3)	Concordo parcialmente (4)	Concordo totalmente (5)
Estou preocupada com a segurança dos meus dados pessoais decorrentes do uso de VTO. (1)	○	○	○	○	○
Preocupa-me que as marcas que usam VTO não sigam padrões éticos na recolha e uso de dados. (2)	○	○	○	○	○

Fim do bloco: Ética e Privacidade

Início do bloco: Perguntas abertas

P7 Qual foi, na sua opinião, o ponto mais positivo que retira da sua experiência com Virtual Try-On?

_____

P8 Qual foi, na sua opinião, o ponto mais negativo que retira da sua experiência com Virtual Try-On?

_____

Fim do bloco: Perguntas abertas

Início do bloco: Familiaridade com Tecnologia

P9 Indique qual é o seu nível de familiaridade com Virtual Try-On.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Muito baixo	○	○	○	○	○	Muito alto

P10 Caso tenha experimentado anteriormente Virtual Try-On, por favor, assinale todas as opções abaixo que se aplicam.

- ☐ Maquilhagem (1)
- ☐ Roupa e/ou calçado (2)
- ☐ Óculos (3)
- ☐ Jóias (4)
- ☐ Mobiliário e Decoração de Interiores (5)
- ☐ Penteado e Cabelo (6)
- ☐ Outros (7)

Fim do bloco: Familiaridade com Tecnologia

Início do bloco: Hábitos de Consumo

P11 Costuma comprar produtos de maquilhagem?

- ○ Sim (1)
- ○ Não (2)

Fim do bloco: Hábitos de Consumo

Início do bloco: Hábitos de Consumo

P12 Se sim, indique com que frequência costuma comprar produtos de maquilhagem.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Muito Raramente	○	○	○	○	○	Muito Frequentemente

P13 Se sim, indique com que frequência costuma comprar cada categoria de produtos de maquilhagem.

	Muito Raramente (1)	(2)	(3)	(4)	Muito Frequentemente (5)
Rosto: Base, Blush, Corretor, Bronzer, Iluminador, etc. (1)	○	○	○	○	○
Olhos: Sombras de olhos, Máscara de pestanas, Eyeliner, etc. (2)	○	○	○	○	○
Lábios: Batons, Gloss, Lápis de lábios, etc. (3)	○	○	○	○	○

P14 Responda às seguintes afirmações de acordo com o que melhor caracteriza o seu comportamento.

	Discordo totalmente (1)	Discordo parcialmente (2)	Nem concordo nem discordo (3)	Concordo parcialmente (4)	Concordo totalmente (5)
Tenho um grande interesse em comprar produtos de maquilhagem. (1)	○	○	○	○	○
Prefiro experimentar os produtos na minha pele antes de comprar. (2)	○	○	○	○	○
Prefiro comprar produtos de maquilhagem em lojas físicas do que em lojas online. (3)	○	○	○	○	○

Fim do bloco: Hábitos de Consumo

Início do bloco: Familiaridade Marca

P15 Classifique o seu nível de familiaridade com a marca M·A·C Cosmetics.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Muito baixo	○	○	○	○	○	Muito alto

P16 Classifique a sua impressão da qualidade dos produtos da marca M·A·C Cosmetics.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Muito má	○	○	○	○	○	Muito boa

P17 Já comprou produtos desta marca?

- ○ Sim (1)
- ○ Não (4)

P18 Se respondeu sim, com que frequência compra produtos desta marca?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Muito raramente	○	○	○	○	○	Muito frequentemente

P19 Já conhecia esta funcionalidade de Virtual Try-On disponibilizada pela marca M·A·C Cosmetics?

- ○ Sim (1)
- ○ Não (2)

Fim do bloco: Familiaridade Marca

Início do bloco: Foto

P20 Selecione que tipo de fotografia utilizou na sua experiência de hoje com Virtual Try-On.

- ○ A minha própria fotografia. (1)
- ○ A fotografia de um modelo. (2)

Fim do bloco: Foto

Início do bloco: Dados Demográficos

P21 Por favor, indique a sua idade.

_____

P22 Como descreveria o seu rendimento familiar em comparação com outras famílias que conhece?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Muito abaixo da média	○	○	○	○	○	Muito acima da média

Appendix B - Model Picture (selected from the Chicago Face Database [34])

Appendix C - Informed Consent Form

TERMO DE CONSENTIMENTO INFORMADO
[ORIGINAL]

REFERÊNCIA ESTUDO: SPI23_24_1ºs_MPIM_EXP
NOME DO ESTUDO:
Experiência do Consumidor de Cosmética em Plataformas de Virtual Try On
INVESTIGADOR RESPONSÁVEL: Marília Prada

Objetivo do Estudo

Neste estudo, estamos interessados em explorar de que forma os consumidores de produtos cosméticos interagem com plataformas que permitem testar virtualmente esta categoria de produtos.
Especificamente, será convidado a experimentar uma plataforma de Virtual Try-On de maquilhagem e a partilhar a sua perceção sobre a plataforma e a marca. Adicionalmente serão também colocadas questões sobre os seus hábitos de consumo desta categoria de produtos e traçados os perfis sociodemográficos dos participantes. Não existem respostas certas nem erradas, estamos apenas interessados na sua opinião acerca do tema.

Condições do Estudo

O tempo previsto de cada sessão é de 30 minutos.

Benefícios da Participação

A participação neste sistema tem como objetivo complementar a formação metodológica dos estudantes de Licenciatura com a passagem por situações concretas de investigação no Laboratório de Psicologia, em diferentes domínios desta disciplina, na posição de participante e simultaneamente de estudante, favorecendo a aprendizagem sobre as regras da investigação e a reflexão sobre o modo como a experienciaram.

Voluntariado

Este sistema formativo tem um carácter voluntário. O participante tem a possibilidade, por motivos éticos, de negar a participação ou de se retirar do estudo, a qualquer momento, sempre que assim o entender.

Confidencialidade, Privacidade e Anonimato

De acordo com as normas da Comissão de Proteção de Dados, os dados recolhidos são anónimos e a sua eventual publicação só poderá ter lugar em Revistas da especialidade. O ecrã será gravado enquanto utiliza a plataforma de Virtual Try On, exclusivamente para efeitos de codificação e análise da sua experiência. Poderá ser requisitada a recolha de uma fotografia para a realização da experiência. A identidade dos participantes não será divulgada e os investigadores tomarão todas as precauções para assegurar a confidencialidade dos dados.

Tanto as gravações como as fotografias apenas estarão acessíveis a colaboradores do projeto, sendo o seu armazenamento em lugar seguro (protegido por palavra-passe) da responsabilidade da Investigadora Principal (Marília Prada). Além disso, serão posteriormente eliminadas (período de armazenamento até 5 anos após gravação).

Pré-requisitos

Ao aceitar colaborar nesta investigação, assume que:

- Compreende a informação anteriormente apresentadas acerca dos objetivos do estudo e a utilização dos seus dados.
- Aceita o registo vídeo do ecrã durante a utilização da plataforma de Virtual Try On nos termos acima descritos.

Estamos disponíveis para esclarecer quaisquer questões acerca da sua participação no estudo antes de proceder.

Caso tenha alguma outra questão/comentário acerca do estudo ou do projeto em que este se insere, poderá também contactar a Investigadora Principal através do email marilia_prada-iscte.pt.

[A preencher pelo/a Participante]
Tendo tomado conhecimento sobre a informação disponível do estudo, declaro aceitar participar.

Data: ____ /____ /____

Nome (legível): _____

Assinatura: _____

[A preencher pelo Investigador/a]
Confirmo que o/a participante leu o termo de consentimento informado e que, tanto quanto é do meu conhecimento, compreendeu os detalhes nele apresentados e recebeu uma cópia do documento.

Data: ____ /____ /____
Nome (legível): _____

Assinatura: _____

Appendix D - Instructions for the Experimental Procedure

GRUPO A – Fotografia do participante.

Estudo realizado no âmbito de mestrado de Tecnologias Digitais para o Negócio.

O autor e envolvidos na recolha de dados comprometem-se a manter a confidencialidade e devida anonimização de todos os dados recolhidos.

- ➔ A duração esperada do estudo é de 30 minutos.
- ➔ Este estudo será dividido em 2 fases:

1º) Experiência online com Virtual Try-On. (através de link)

2º) Realização de um inquérito relativo à experiência de interação da fase anterior. (através de link)

- ➔ Para esta experiência será necessário recolher uma fotografia sua que ficará guardada no ambiente de trabalho do seu computador.

O objetivo é interagir com o Virtual Try-On de uma página web, experimentado virtualmente produtos de maquilhagem.

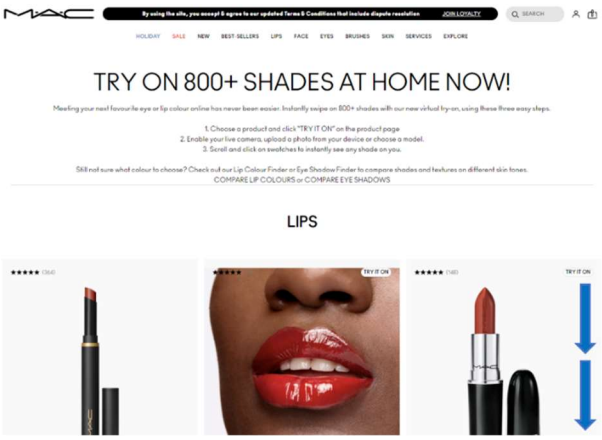
Para que serve e o que é o Virtual Try-On?

O Virtual Try-On é uma tecnologia que permite experimentar virtualmente produtos, usando imagens geradas por computador, simulando a presença física desses produtos num ambiente virtual.

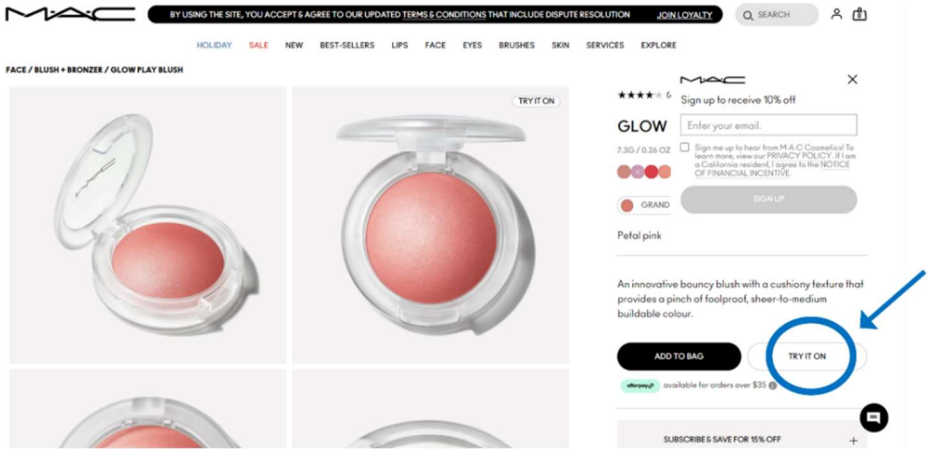
Instruções:

1ª FASE: VIRTUAL TRY-ON (o monitor será gravado)

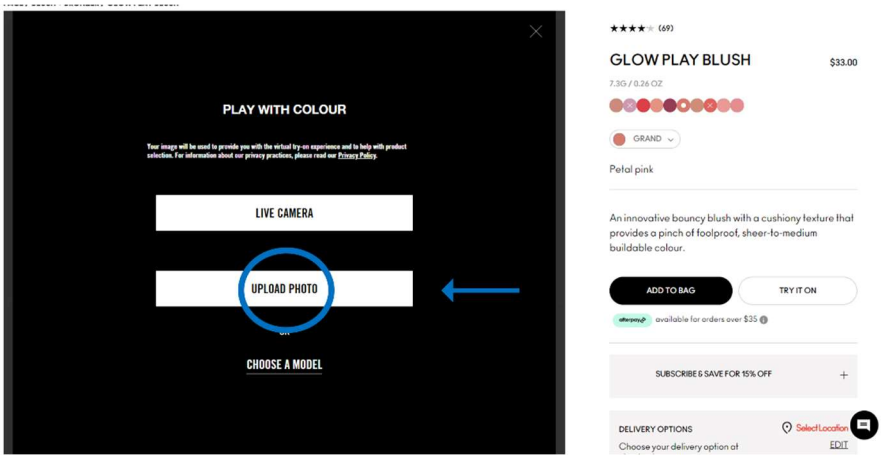
1. Clique no link www.maccosmetics.com/virtual-try-on.
2. Após aceder a este link, explore os vários tipos de produtos disponíveis fazendo *scroll* para baixo (pode experimentar produtos de rosto, lábios e/ou olhos).



3. Após escolher um produto, selecione a opção "**VIRTUAL TRY-ON**".



4. De seguida selecione a opção "**UPLOAD PHOTO**" e carregue **a sua fotografia pessoal** localizada no ***Desktop*** do seu computador para proceder à experimentação do produto.



5. Caso tiver interesse em experimentar outros produtos que ache interessantes, retorne à página www.maccosmetics.com/virtual-try-on, e repita os passos anteriores.
6. Repita este processo as vezes que quiser e explore os produtos à sua vontade.
7. Quando desejar **terminar a sua experiência**, sinalize-o, batendo à porta do cubículo, para procedermos à finalização da gravação do seu ecrã.

2ª FASE: INQUÉRITO

1. Após a interação com o Virtual Try-On, aceda ao link abaixo e responda por favor às questões: https://iscteiul.co1.qualtrics.com/jfe/form/SV_cSgY08R5G6bUx2C.

Obrigada!

GRUPO B – Fotografia de modelo. (Chicago Face Database)

Estudo realizado no âmbito de mestrado de Tecnologias Digitais para o Negócio.

O autor e envolvidos na recolha de dados comprometem-se a manter a confidencialidade e devida anonimização de todos os dados recolhidos.

- ➔ A duração esperada do estudo é de 30 minutos.
- ➔ Este estudo será dividido em 2 fases:

1º) Experiência online com Virtual Try-On. (através de link)

2º) Realização de um inquérito relativo à experiência de interação da fase anterior. (através de link)

- ➔ Para esta experiência será necessário utilizar uma fotografia de um modelo que poderá encontrar no ambiente de trabalho do seu computador.

O objetivo é interagir com o Virtual Try-On de uma página web, experimentado virtualmente produtos de maquilhagem.

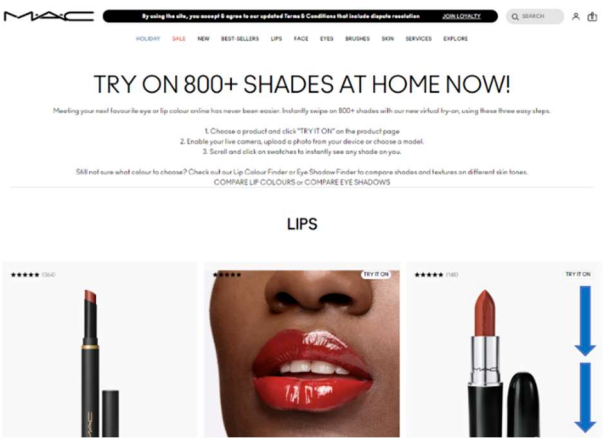
O que é e para que serve Virtual Try-On?

O Virtual Try-On é uma tecnologia que permite experimentar virtualmente produtos, usando imagens geradas por computador, simulando a presença física desses produtos num ambiente virtual.

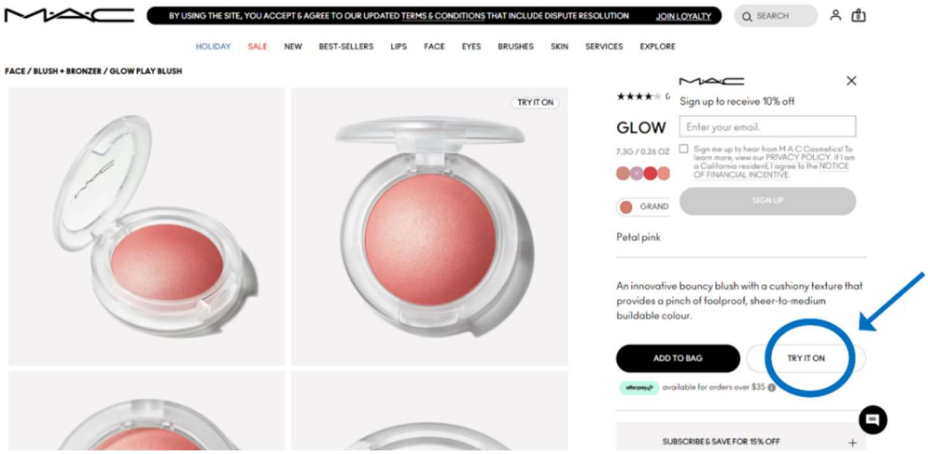
Instruções:

1ª FASE: VIRTUAL TRY-ON (o monitor será gravado)

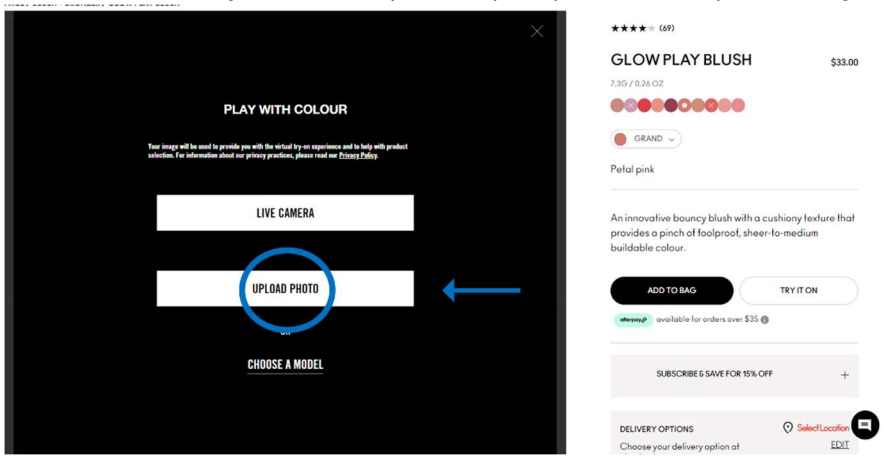
1. Clique no link www.maccosmetics.com/virtual-try-on.
2. Após aceder a este link, explore os vários tipos de produtos disponíveis fazendo *scroll* para baixo (pode experimentar produtos de rosto, lábios e/ou olhos).



3. Após escolher um produto, selecione a opção "**VIRTUAL TRY-ON**".



4. De seguida selecione a opção "**UPLOAD PHOTO**" e carregue **a fotografia da modelo** localizada no ***Desktop*** do seu computador para proceder à experimentação do produto.



5. Caso tiver interesse em experimentar outros produtos que ache interessantes, retorne à página www.maccosmetics.com/virtual-try-on, e repita os passos anteriores.
6. Repita este processo as vezes que quiser e explore os produtos à sua vontade.
7. Quando desejar **terminar a sua experiência**, sinalize-o, batendo à porta do cubículo, para procedermos à finalização da gravação do seu ecrã.

2ª FASE: INQUÉRITO

2. Após a interação com o Virtual Try-On, aceda ao link abaixo e responda por favor às questões: https://iscteiul.co1.qualtrics.com/jfe/form/SV_cSgY08R5G6bUx2C.

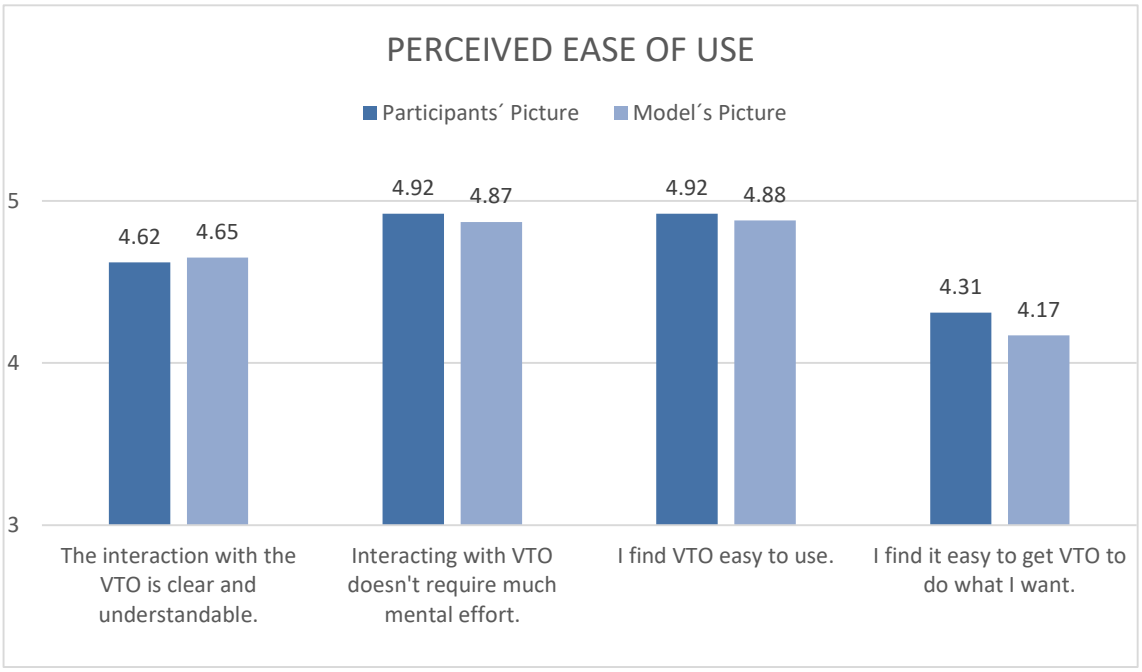
Obrigada!

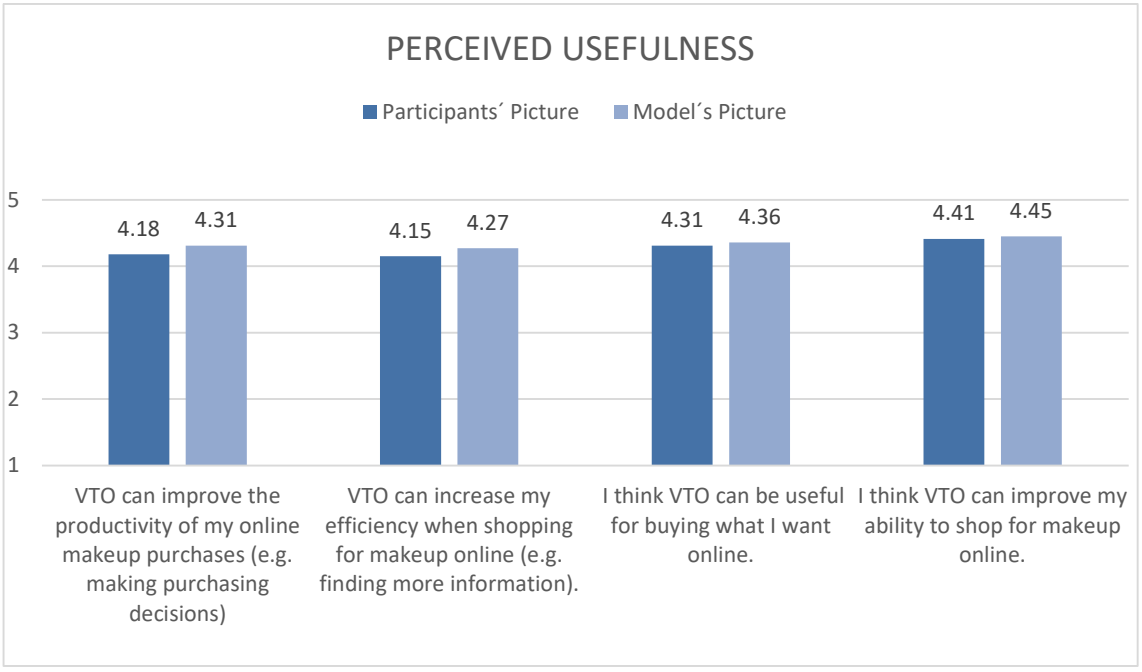
Appendix E - Survey Instruments: Measures and Questions Employed

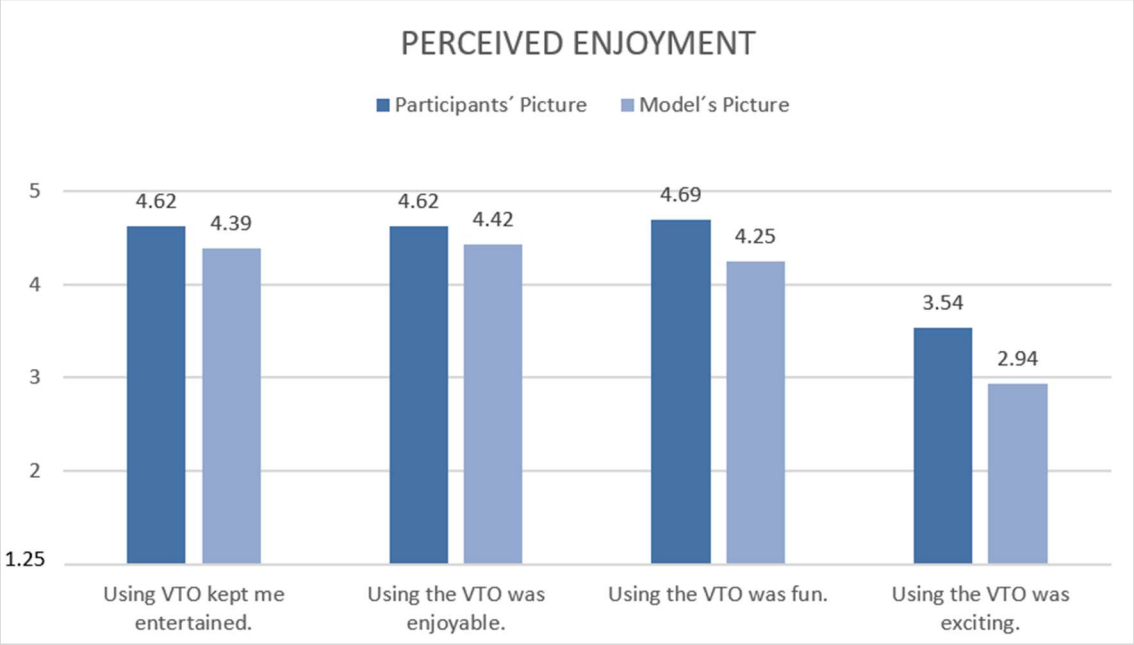
Main topics	Measures	Questions
Group question (Developed by the author)	Closed-ended question “My own photo” or “A photo of a model”.	1. Select which type of picture you used in your Virtual Try-On experience today.
Demographic data (Developed by the author)	Open-ended question.	1. Please indicate your age.
	5-point scale from “Far below average” to “Far above average”.	2. How would you describe your family income compared to other families you know?
Consumption Habits (Developed by the author)	Closed-ended question “Yes” or “No”.	1. Do you usually buy makeup products?
	5-point scale from “Very rarely” to “Very often”.	2. If yes, how often do you buy makeup products?
		3. If yes, how often do you buy each category of makeup product? 3.1. Face: Foundation, Blush, Concealer, Bronzer, Highlighter, etc. 3.2. Eyes: Eyeshadows, Eyelash mascara, Eyeliner, etc. 3.3. Lips: Lipsticks, glosses, lip pencils, etc.
	5-point scale from “Strongly disagree” to “Strongly agree”.	4. Answer the following statements according to what best characterises your behaviour. 4.1. I am very interested in buying makeup products. 4.2. I prefer to try products on my skin before buying. 4.3. I prefer to buy makeup products in physical stores rather than online.
Familiarity with VTO (Developed by the author)	5-point scale from “Very low” to “Very high”.	1. Please indicate your level of familiarity with Virtual Try-On.
	Multiple responses.	2. If you have previously tried Virtual Try-On, please select all the options below that apply. 2.1. Makeup 2.2. Clothing and/or Footwear 2.3. Glasses 2.4. Jewellery 2.5. Furniture and Interior Design 2.6. Hairstyle 2.7. Other
Familiarity with the Brand (Developed by the author)	5-point scale from “Very good” to “Very bad”.	1. Please rate your impression of the quality of M·A·C Cosmetics products.
	Closed-ended question “Yes” or “No”.	2. Have you ever bought products from this brand?
	5-point scale from “Very rarely” to “Very often”.	3. If yes, how often do you buy products from this brand?
	Closed-ended question “Yes” or “No”.	4. Did you know about this Virtual Try-On feature available from M·A·C Cosmetics?
Qualitative questions (Developed by the author)	Open-ended questions.	1. What was the most positive aspect about your experience with the Virtual Try-On? 2. What was the most negative aspect about your experience with the Virtual Try-On?

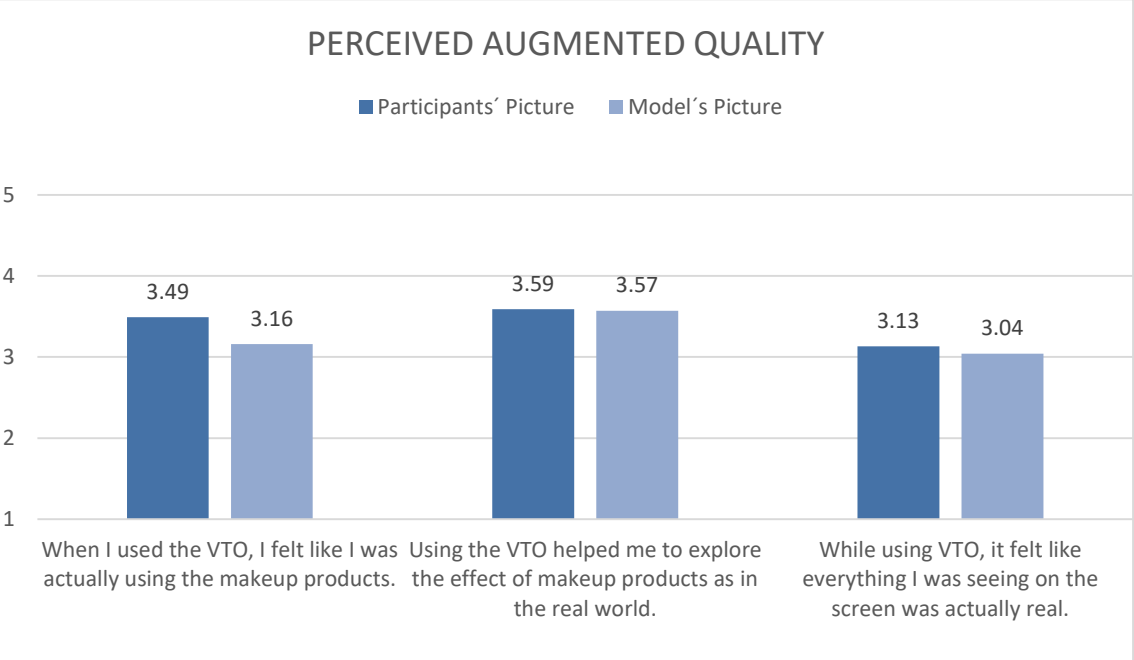
Appendix F - Ratings of Quantitative Measures

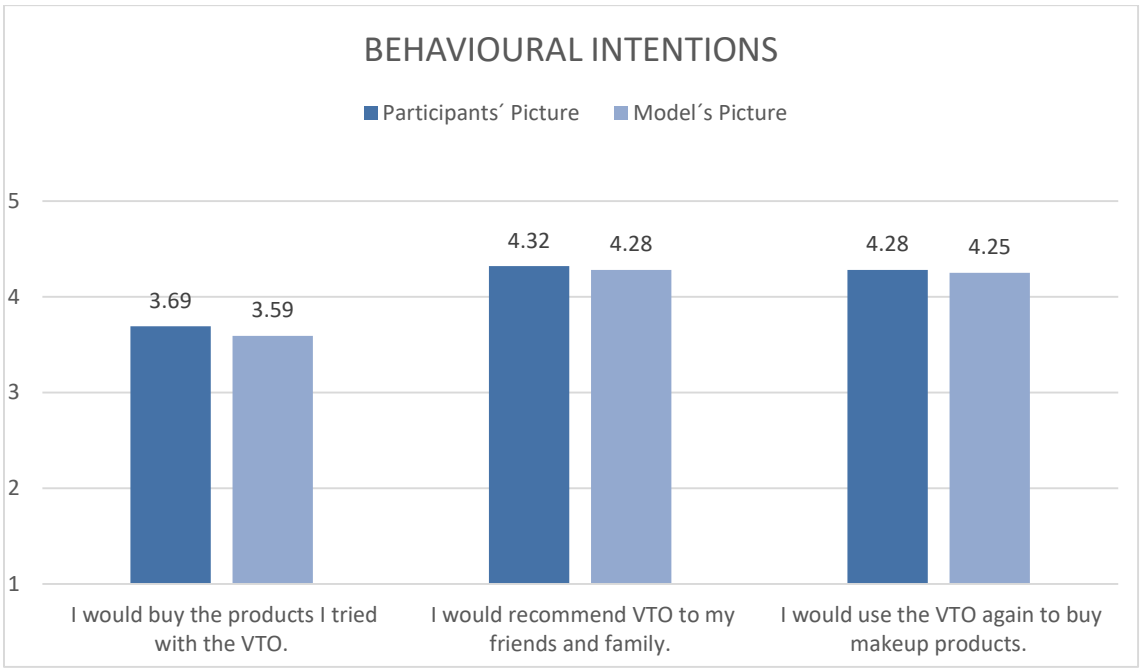
Ratings for Each Evaluative Dimension (Mean Scores per Group and per Item)

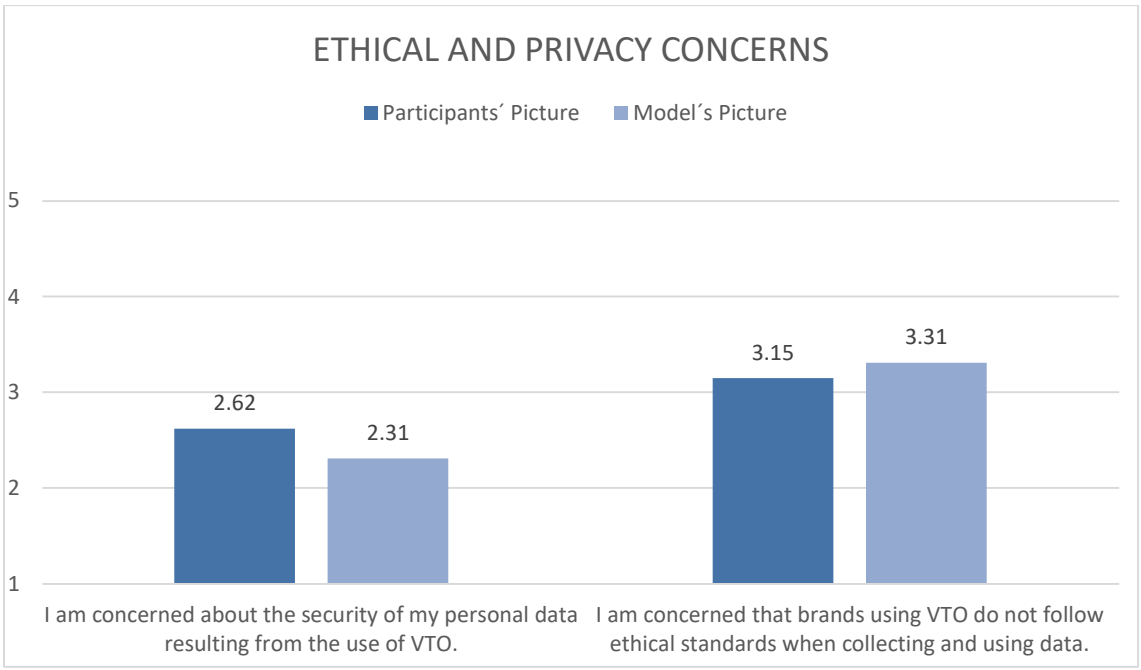





PERCEIVED ENJOYMENT
Participants´ Picture
Model´s Picture
5
4
3
2
1.25
4.62
4.39
4.62
4.42
4.69
4.25
3.54
2.94
Using VTO kept me entertained.
Using the VTO was enjoyable.
Using the VTO was fun.
Using the VTO was exciting.


PERCEIVED AUGMENTED QUALITY
Participants´ Picture
Model´s Picture
5
4
3
2
1
3.49
3.16
3.59
3.57
3.13
3.04
When I used the VTO, I felt like I was actually using the makeup products.
Using the VTO helped me to explore the effect of makeup products as in the real world.
While using VTO, it felt like everything I was seeing on the screen was actually real.


BEHAVIOURAL INTENTIONS
Participants´ Picture
Model´s Picture
5
4
3
2
1
3.69
3.59
4.32
4.28
4.28
4.25
I would buy the products I tried with the VTO.
I would recommend VTO to my friends and family.
I would use the VTO again to buy makeup products.


ETHICAL AND PRIVACY CONCERNS
Participants´ Picture
Model´s Picture
5
4
3
2
1
2.62
2.31
3.15
3.31
I am concerned about the security of my personal data resulting from the use of VTO.
I am concerned that brands using VTO do not follow ethical standards when collecting and using data.

Ratings for VTO Engagement Metrics (Mean Scores per Group)