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JEANNE BOTELHO MACIEL

EXPLORING NEW FRONTIERS FOR ONLINE OLFACTORY MARKETING

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TERMO DE APROVAÇÃO

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EXPLORING NEW FRONTIERS FOR ONLINE OLFACTORY MARKETING

Por

JEANNE ROSALINA BOTELHO MACIEL

Tese aprovada em 05 de julho de 2024 como requisito parcial para obtenção do grau de Doutora no Programa de Pós-Graduação em Administração, área de concentração em Administração Estratégica, da Escola de Negócios da Pontifícia Universidade Católica do Paraná.

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DEDICATÓRIA

To my daughter.

ACKNOWLEDGMENTS

Working on this project, at least for me, has been a journey of exploration into issues of human perception and what can influence behavior as incredible as Alice in Wonderland's quest for self-knowledge! So, I'd like to start by thanking everyone who participated in various ways. Doubtlessly, I'd like to start by thanking God. For guiding me, for giving me perseverance in moments of weakness, and for allowing me to complete this journey with some answers, but most of all with many more questions and possibilities for future quests. And it took a lot of people to make this journey happen. Some more actively than others, but many people have been part of this journey! Without their participation none of this would have happened and I am very grateful to each and every one of them.

When I first thought about researching sensory marketing insights, I imagined that it wouldn't be easy because of the number of variables we would have to consider. However, when I decided to look at olfactory marketing with a focus on the possibilities of digital reality, I didn't realize how challenging and thrilling it would be! And how fascinating! So, I'd like to start by thanking my daughter. Not only for her patience - during all the time I had to give up being with her for doing the research and the data collection in the experiments for over two years - but also for her constant motivation, her curiosity to listen and to question the progress of my studies. Many of her unpretentiously provocative questions motivated me to look for new possibilities. I dare say you were my "Mad Hatter" on this journey. My family for putting up with me and supporting me, especially my sister, my "March Hare", for the speculative conversations, the academic exchanges, and for often talking sense into me.

I would also like to thank someone who has been more than an advisor since my Master: she has been a mentor, a trench partner, a guide in this process, and in so many ways, my "White Rabbit": Thank you, PhD. Eliane Francisco, for provoking me to leap into this journey, to go further, to do things I didn't even think I had the capacity and strength to do, in short, for believing in me more than I believed in myself.

It wouldn't have been possible to carry out this study if Michele de Souza hadn't trusted us with her yet-to-be commercialized Cycor´s digital aroma technology. As our challenge was

to test the possibility of virtual access to fragrance, if the company hadn't believed in this study, our entire proposal to analyze solutions with online possibilities would not have been possible.

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And because so many people took part in this adventure - a total of 684 in the collection phase alone - I would like to thank you all. I don't remember your names, but I do remember your faces and the generosity with which you gave up your time to be interviewed about the brands developed for the study.

It's a strange feeling to finally be writing these thank-you notes. I dare say it's a contradictory moment, because what seemed to be a story with an end has turned out to be the beginning of new journeys and possibilities. Possibilities that may encourage other people like me to go down this 'rabbit hole' of olfactory sensory marketing research.

EPÍGRAFE

"What do you know about this business?" the King said to Alice.
"Nothing," said Alice.
"Nothing whatever?" persisted the King.
"Nothing whatever," said Alice.
"That's very important," the King said, turning to the jury.

Lewis Carroll

ABSTRACT

One of the senses that has emerged as a trend in marketing in recent years is olfaction. In offline research, it has demonstrated to have a certain influence on brand perception, purchase intention and time perception, among other things. In this context, questions such as: what if it were possible to make scent available digitally? Could a digital scent have influence in consumer behavior and perception? So, the aim of this study was to verify if a digital scent would influence consumer intention and choice. To this end, this thesis has been structured in three main studies that were presented in three articles. First, we conducted a comprehensive systematic review of 90 multidisciplinary theoretical and empirical studies to identify key research themes related to olfactory marketing. To conduct the trials, 628 people were interviewed individually, divided into a series of two 2x1 single-factor laboratory experiments and another 37 people in an equally 2x1 field experiment. We used a new non-chemical olfaction technology called "Scent by Sounds" using a in the first experiment a stimulating odor (related to food) and in the second a calming fragrance (non-food related). Additionally, we conducted a field experiment, to understand if people's response to the soothing digital scent would be similar to the chemical scent when it comes to food consumption. Throughout the experiments, kind of digital scent showed a number of different responses. For instance, our results in the first research show that the coffee digital odor can influence the consumer's behavior, regardless of whether the context is congruent or not. Moreover, both the formative elements of chemical aroma and the biological control elements of olfaction have no interference in the perception of the virtual aroma. On the second study, where we tested a non-food olfactory track, although we couldn't confirm our hypothesis that the flower and talcum powder notes would have influence in consumer´s choice, attention and time perception regardless of congruence, we found indications that and this pleasant virtual aroma reduces the beverage and food consumption and it makes people take their time doing the activities. The contributions of this study to academia would be to carry out first tests of a technological proposal for totally virtual aroma and to managers, it would be to verify one of the technological possibilities for olfactory marketing that could be adapted to the online reality.

Keywords
Digital Aroma; Online Olfactory Marketing; Consumer Behavior.

ILLUSTRATION INDEX

THESIS STRUCTURE

The thesis is structured in four parts: The first part is the rationale we have followed, and which has allowed us to propose our thesis statement. The second is the theories and main findings of previous studies on the topic related to this research. Considering the findings of chemical olfaction offline research, on olfactory functioning, cognitive theories that apply to smell, which can help understand the influence of smell and what has already been studied on the potential and opportunities for online olfactory marketing. The third part consists of the sequence of articles, the first of which was a systematic review that provided all the background for the two experimental studies examined in the following articles, and the fourth part contains the conclusions and limitations of the studies.

PART 1 **CHARACTERIZATION OF THE RESEARCH**

It covers the introductory part of the studies, contextualizes the research problem, identifies the managerial and theoretical justifications, general objectives, theoretical framework, and theories adopted in subsequent studies.

Section 1.1 *introduces the research context.*
Section 1.2 *highlights the theoretical justifications of this thesis.*
Section 1.3 *emphasizes the managerial reasons for the study.*
Section 1.4 *presents the thesis statement that guides this research.*
Section 1.5 *identifies the main objectives of the study.*

PART 2 **THEORETICAL CONTEXTUALIZATION**

Presents the structural concepts and theoretical contextualization of the studies.

PART 3 **STUDIES DEVELOPED**

Part 3 includes the three articles that are part of this thesis. The organization of articles is described in Section 3 of Part 2.

Article 1 *Exploring new frontiers of online olfactory marketing*
Article 2 *Digital aroma: Testing possibilities for Olfactory Marketing in the online environment*
Article 3 *Beyond digital scent: Verifying its influence on food consumption and the perception of individuals*

PART 4 **CONCLUSIONS**

It presents the conclusion of the studies, identifies the study limitations and future research for the academic development of the theme.

Section 4.1 *Conclusions on the main objective*
Section 4.2 *Conclusions on the specific objectives*
Section 4.3 *Limitations and future studies*

SUMMARY

PART 1

"It's kind of fun to do the impossible." – Walt Disney

This thesis is structured to reflect the essential stages in the development of the study. The first section provides a concise introduction to the research, outlining the context, rationale, research questions and objectives. It also highlights the contribution of each article to the overall goals of the thesis, explores the common theme of the research, new opportunities, and provides a comprehensive overview of the studies conducted.

1 INTRODUCTION

Sensory marketing has demonstrated its ability to influence consumer perceptions and decisions in offline research (Krishna, 2012; Véga-Gómez et al., 2020). In general, consumers' relationships with brands can be influenced by their sensory experiences. It has been studied over the last 50 years to better identify how they can be intentionally developed and to understand the range of possible interference of the senses (Krishna et al., 2016; Krishna et al., 2017; Spence, 2020a, 2020b). Back in the 70s, Kotler (1973) had already observed that the perceptions, associations and emotions that can be accessed through the immersive sensory experience are indeed essential for brands to establish a stronger connection with consumers and thus an emotional bond (Roxana & Ioan, 2013; Spence, 2015a).

Recognizing that humans are multisensory and capable of processing multiple sensory inputs simultaneously, marketers must seek to understand how this sensory immersion can occur and develop strategies that align the senses with their strategic goals (Lawless & Engen, 1977; Lovelock et al., 2011; Doucé & Adams, 2020).

A significant number of studies have focused on offline olfactory marketing, investigating its impact on various aspects such as taste perception (Spence & Yousef, 2015; Spence, 2015; Jang & Lee, 2019; Petit et al. 2022), brand perception (Altamore et al., 2018; Darabi & Mirabi, 2018), purchase intention and lingering in a place or task (Krishna, 2012; Véga-Gómez et al., 2020), environmental perception (Lai, 2018; Spence, 2020b; De Luca & Botelho, 2021; Spence, 2021a), concentration (Olofsson et al., 2017; Spence, 2021a), and time perception (Leclerc et al., 1995; Spangenberg et al., 1996; Herz, 2004).

However, the extension of these findings to the online sphere remains relatively unexplored. Spence (2017) and Petit et al. (2019) found that technology is crucial in translating or adapting olfactory experiences to digital platforms. Traditionally, online olfactory experiences have relied on triggering memories through visual and auditory stimuli, associating images or sounds with specific smells.

However, it became clear to us that some of the gaps identified in these studies presented great research opportunities, given the tremendous advances in online capabilities, especially in the aftermath of the pandemic. We started with some questions like: What if it were possible to actually deliver scents digitally? What if it were possible to allow users to smell virtually, not just remember what that smell felt like? Could virtual scents influence how consumers behave, choose, focus, and perceive time? Could a digital scent do this even in the absence of a physical olfactory source? Does the congruence between the digital scent and the specific context in which it is presented enhance or amplify this influence? With these questions as a starting point, we proposed to search for these answers.

Furthermore, considering the nature of a fragrance - stimulating or calming - it would also be relevant to verify if these scents in digital, would influence the consumer's choice and perceptions (Spangenberg et al., 1996). To do this, we looked at the existing literature in areas other than psychology and consumer behavior, like medicine and HCI, to find methods or technologies that enable virtual olfaction.

To answer these questions, we began our investigation with a multifaceted research approach. First, we conducted a comprehensive systematic review of 90 multidisciplinary theoretical and empirical studies. Our aim was to identify key research themes related to the influence of smell on behavior, aroma properties, individual differences, olfactory technologies, and its interplay with multiple senses. This review serves as a foundation for our subsequent experimental work.

Next, two 2x1 experimental single-factor studies are conducted using a new technological solution designed to enhance non-chemical smell. This technology, called "Scent by Sound", supposedly translates sound waves into odors, which is why the developers call them "olfactory tracks".

We collected 628 responses in both experiments with the brands developed for the study - Kahvia and Känner - between the tests with the technology, the pre-tests and the data collection. In both cases, the mechanics were strictly the same and the experimenters weren't aware of the purpose of the interview.

In the first experiment, we used a coffee scent track. One sample was presented to a fashion brand (non-congruent odor) and another to a gourmet coffee brand (congruent). For each brand, participants were divided into an exposed group and a control group. In this study, we tested the influence of the scent track on consumers' intentions and behavior, and the possible interference of congruence. We also tested whether the formative elements of aroma found in the literature and the biological filters of chemical olfactory perception would have an influence in the digital scent.

In the second study, we used a digital scent with floral and talcum notes; the mechanism and the branded products were the same. In this experiment, we analyzed the influence of non-food calming aromas on consumer behavior when choosing coffee break beverages, the possible influence on concentration, and the perception of time. We also investigated the physiological control elements of the chemical aroma and whether congruence would have a potentiating effect. However, to compare the behavior under the exposure to the digital vs. the chemical scent, we felt the need to develop a 2x1 field experiment. It was used a non-food calming chemical scents to test the possible influence on food consumption behavior. Two samples (exposed and control) were randomly selected for a total of 37 people.

By manipulating some of the factors that influence the chemical sense of smell, and taking into account psychological theories such as schema theories that explain possible cognitive associations, we wanted to find out if the mechanisms of digital scents could influence consumer behavior.

Therefore, this thesis aims to contribute to the field of olfactory marketing and increase our understanding of how digital scent can potentially be used to enhance online consumer experiences and create stronger brand relationships.

1.1 Research context

Competitiveness and the need to differentiate in the markets have led brands to consider the consumer's senses as marketing tools. In this context, smell has gained ground in offline research, mainly because brands have started to consider it for its ability to access memories, emotions and the limbic system, stimulating instinctive responses. Lindstrom (2012) and Solomon (2016) highlight that although smell is third in the hierarchy of people's daily use, after sight and hearing, it is the sense that can most easily access consumers' emotions, affections and long-term memories (Engen & Ross, 1973). This would give it the ability to develop stronger, longer-lasting bonds between brands and their consumers. This view is complemented by Errajaa et al. (2021), who point out that olfactory marketing also has the appeal of providing a strategic competitive advantage, both to strengthen a company's identity and to improve its performance.

Much because the advantage improvement for brand strategies identified offline, studies have shown that there is an overwhelming need to examine how to make fragrance available in the online environment, given its marketing potential (Spence et al., 2017; Olofsson et al., 2017; Petit et al., 2019, Chatterjee, 2022; Brengman et al., 2022). It is easier to understand this urgency when we look at the data on the potential of cyberspace. Consumers are connecting and interacting online more frequently and for longer periods of time. More than 66.2% of the world's population is already online, spending an average of 6.40 hours per day online (We Are Social Report, 2024). In this context, companies have realized that it is important to be willing to adapt and innovate in digital strategies in order to remain competitive online.

With the proposal of new technologies, initially developed for medical purposes by the fields of Human-Computer Integration (HCI) and Cybernetics, this limitation of remote access to olfactory stimuli (prime) could be overcome. In 2021, tests had begun on some possibilities for overcoming the barrier of the absence of the original olfactory source in order to effectively "feel" a scent digitally. As part of this research, a proposal was selected in which the mechanism would consist of stimulating the sense of smell using inaudible sound waves that could be made available on any device that could open an MP3 file. This "digital scent" would act on the cerebral system. This technology would eliminate the need for chemical access via the olfactory neuroepithelium (a tissue rich in nerve endings capable of identifying and transporting the chemical olfactory stimulus that is located in the nose and mouth).

In order to understand how marketing could eventually use it online, it is important to have an awareness of how the smell works psychosocially. Not by using an olfactory memory, but by accessing the olfactory system, the sensation of an odor. Therefore, for this study, it is important to get how this technology could work physiologically and psychologically. We recognized a complementary theory and model that explains the association that the scent could promote: originally Bartlett's (1932) schema theory and Tulving's (1982) coding or content model. With these theoretical underpinnings, the purpose of this study is to test if the digital olfactory stimulus can be captured and decoded virtually and if it would have any influence on the consumer's intention, behavior, and perception.

1.2 Theoretical reason

Scholars such as Spence et al. (2017), Olofsson et al. (2017), and Petit et al. (2019) have highlighted the need to develop technologies that facilitate virtual olfaction. This need has been emphasized by Chatterjee (2022) and Panagiotakopoulos et al. (2022) as consumers increasingly adopt online environments and, ultimately, the metaverse. Therefore, the primary objective of this research was to investigate whether there is a potential impact of a stimulating (food-related) or calming (non-food-related) digital scent on consumer intention, behavior, concentration, and time perception.

While there is a growing inclination to develop solutions for virtual aroma, texture, and olfactory perception to enhance online immersion, empirical studies in this area remain scarce. Academic interest in olfactory stimuli stems from their demonstrated effects on various offline consumer responses, including physiological responses such as salivation (Spence, 2011), taste perception (Spence, 2011; Spence, 2015; Sandell, 2019a; Petit et al, 2021), perceived quality (Spence, 2015; Biswas & Szocs, 2019; Berčík et al., 2021; Doucé, 2022), environmental influence (Stenslund, 2015; Henshaw et al., 2016; Spence, 2020a), and purchase intention (Lovelock et al., 2011; Lindstrom, 2012; Doucé et al., 2016; Véga-Gómez et al., 2020), highlighting the potential of olfactory marketing.

Furthermore, a research gap identified by scholars highlights the need for empirical investigations to explore emerging ways to enable virtual olfaction that are applicable both online and in the metaverse (Spence et al., 2017; Suominen et al., 2018; Petit et al., 2019; Panagiotakopoulos et al., 2022; Doucé, 2022; Brengman et al., 2022; Chatterjee, 2022).

Thus, the aim of our study was to evaluate the viability of implementing a cybernetically derived technological solution for virtual scent development. By analyzing the physiology of the olfactory system and psychological theories such as schema coding (Bartlett, 1932) and Tulving's content specificity model (1982), we sought to understand how such a technology might work and influence consumer behavior.

Inspired by Gorn's (1984) study, we designed experiments to measure real-life choices considering a stimulating (food-related) and a calming (non-food-related) digital scent and to test if there is an influence on consumer intention, behavior, concentration, and time perception. Also test if there is congruency scent product context interference with both digital scents. In addition, we investigated whether the biological factors that influence chemical odor perception would similarly impact digital scent perception, such as age, sex, medication use, or exposure to COVID-19 (Doty et al., 1974; Ellen & Bone, 1998; Croy et al., 2014; Majid, 2020; Spadera et al., 2022; Dal Bò et al., 2022; Ornati & Kalbaska, 2022; Doucé, 2022; Bochicchio et al., 2023).

Our theoretical contribution would be to propose an understanding of how psychological theories of association can be applied. We considered two theories as the basis for olfactory perception: the schema encoding theory, originally presented by Bartlett (1932), and the encoding or content specificity model, elaborated by Tulving (1982). According to the first theory, memory must be associated not only with the storage of information and the experience of the context surrounding the individual (the world), but also with the meaning that the person attaches to this information. Thus, memory can be related to experiences and organized according to conceptual schemes and the familiarity of each person (Bartlett, 1932; Schwartz & Reisberg, 1991; Neufeld & Stein, 2001; De Luca & Botelho, 2020). Therefore, "the basic units of processing would be the schemata, which consist of 'packets of information' about generic concepts" (Pozo, 1998, p. 138).

In Tulving's model, memory is conceptualized as semantic and episodic, whereas the first theory is long-term and involves categorizing linguistic terms, defining memory, and identifying the brain's normative rules (Tulving, 1982; Neufeld & Stein, 2001; De Luca, Botelho, 2020). Semantic memory concentrates contextual knowledge and must be able to be stored (Majid, 2020; Olfosson et al., 2020). Episodic memory is associated with events,

autobiographical situations, and individual stories. This theory is also associated with recall and recognition. Recall is the ability to identify something from the past, whereas recognition is a process of familiarity that can recall something previously encountered without being identical (Tulving, 1982; Neufeld & Stein, 2001).

Our understanding is that these theories are complementary. When it comes to a potential digital scent, an aroma cue might trigger access to a specific aroma memory association. Based on its schema encoding, this aroma could activate the limbic system, thereby enhancing emotional memory (Gottfried, 2006; Herz, 2004; Neufeld & Stein, 2001; Croy et al., 2014; Olofsson et al., 2017; Zald & Pardo, 2000).

It would also be a scientific contribution to explore a technological possibility that could promote a digital olfactory and to know possible consumer responses to a virtual aroma if applied online. From these experimental tests, we were able to identify both opportunities and limitations that can be explored in future studies. Including the identification of other technologies that could be considered for testing.

1.3 Practical reason

There is a marketing interest in understanding what could attract, engage, and motivate consumers to choose a particular brand (Kotler & Keller, 2018). This need encourages the development of studies that examine individuals' expectations, taking into account biological and psychological aspects that may influence this decision-making process. It is increasingly clear that sensations have an important relevance in consumer decision making and are a topic to be studied by marketing, according to Solomon (2016) and Lindstrom (2012).

One of the senses that has shown great potential is smell. This is largely due to the versatility and potential influence that smell has shown in both olfactory marketing studies and empirical use at the point of sales – POS. A scent has the ability to develop stronger emotional bonds (Lindstrom, 2012; Doucé & Janssens, 2013; Spence, 2021a), trigger memory and develop new associations (Herz, 2004; Gottfried, 2006; Patel & Pinto, 2013; Labrecque, 2021; Petit et al, 2021; Niedenthal et al., 2021) and to alter individual perceptions (Roxana & Ioan, 2013; Errajaa et al., 2021; Doucé, 2022). The memory of a particular aroma or its associations becomes involuntary, it happens without conscious effort (Engen & Ross, 1973; Istomina, 1977; Neufeld & Stein, 2001; Bochicchio et al., 2023). Thus, the memory of a particular aroma

can evoke both positive and negative emotions and moods and is likely to affect stress levels as well (Krishna & Schwarz, 2014; Spence, 2015a; Zhong, et al., 2022).

In other words, it has become a strategic requirement for marketing to understand how to use scent to elicit positive responses and enhance the consumer experience (Véga-Gómez et al., 2020). Olfactory stimuli - which can also be considered as priming according to De Luca and Botelho (2020) - that could create a shortcut to influence consumer behavior via the limbic system and, depending on how a scent is adopted, could favor a brand's image, make the individual feel more engaged, and even promote an increase in sales results (Krishna, 2013; Errajaa et al., 2021; Ornati & Kalbaska, 2022, Doucé, 2022).

Despite the recognized potential to access emotions and long-term memories and to influence individuals' perceptions (Engen & Ross, 1973; Lawless & Engen, 1977; Bhardwaj et al., 2023), one point that recurs as a limitation of previous studies and a recommendation for further research is the need to understand how odors could affect the digital environment (Covington et al., 2018; McMillan, 2021; Brengman et al., 2022). This need is highlighted, for example, in studies such as the one investigating the effect of scents in video games (Olofsson et al., 2017), in theoretical reviews of olfactory technologies, and in trends in online consumer behavior (Spence et al., 2017; Petit et al., 2019; Charttejee, 2022). In addition, the COVID-19 pandemic caused social isolation that increased the need to bring access to this chemical sense into cyberspace, especially given its potential to influence consumer behavior (Bochicchio et al., 2023; Bhardwaj et al., 2023).

With the advance of new technologies developed by HCI or cybernetics, originally for the medical field, there could be the possibility to overcome the challenge of virtuality and make non-chemical scent. So, our objective was to identify and test the technological possibility that could have a better adaptation to the online environment. The selected solutions propose to convert inaudible sound waves into MP3 "scent tracks" without the need of any gadgets. Also, that instead of bringing a memory of an odor, it would allow to feel it through olfactory synapses.

Therefore, there are two main practical contributions of this study: to test whether a digital scent could be perceived and whether it would have an impact on consumer intention and

behavior. We also wanted to see if the digital aroma, whether stimulating (food-related) or calming (non-food-related), would have any impact on the consumer's choice. Additionally, we wanted to see if the biological filters controlling the chemical sense would affect perceiving and influencing the virtual aroma. Also, if product-scent congruence would reinforce this relationship. In other words, our goal was to test, in two different experiments, the influence of digital scent on consumer intentions and behavior in practice. Additionally, we wanted to verify whether the formative elements of smell are relevant in a virtual scent, and whether physiological filters - which can be considered as controlling elements for the perception of chemical scents - act on digital scents. As a plus, we wanted to verify if the notes of the scent (as stimulating in relation to coffee, and calming in relation to talcum and lavender), would influence the consumption of the beverage, in the consumer's concentration and in their perception of time.

1.4 Thesis statement

Due to both the unique properties and psychophysiological effects of odors and their relevance to marketing purposes, there is a growing interest in understanding how odors influence human responses. People have the ability to identify and discriminate up to thousands of scents and respond according to what that scent is associated with in their memory (Engen & Ross, 1973; Spence et al., 2017; Bhardwaj et al., 2023).In previous studies, aroma has been shown to influence consumer perceptions, intentions, and actual behavior (Véga-Gómez et al., 2020; Spence, 2021a; Petit et al., 202; Bhardwaj et al., 2023).

Previous studies have shown that congruence between a product and a fragrance can enhance consumer intention and behavior (Busca et al., 2020; Errajaa et al., 2020). To deepen our understanding of this aspect as well, in this study we investigated whether the influence of a digital scent is altered in different congruence contexts. Thus, we hypothesize that testing in neutral contexts - where there is no inherent connection between the scent and the product - would provide insight into the potential of digital scent technology to motivate action even in the absence of congruence. Later, we will explore the influence of physiological factors and other elements identified in the literature as formative to aroma perception (Véga-Gómez et al., 2020).

Considering this context and understanding how we as humans perceive smell in a chemical sense - linked to human emotions, memories and cognitive processes - we aim to answer this research question: Since smell is originally a chemical sense, if there were a virtual olfactory possibility, would it have an impact on consumer attitudes, behaviors, and/or perceptions?

Therefore, this thesis statement is: **The digital olfactory technology can influence on consumer attitudes, behaviors and perceptions.**

In other words, our thesis is that stimulating food-related digital scent would be able to positively influence consumers' attitude and behavior, and calming non-food-related digital scent would be able to diminish consumers' food consumption while increasing concentration and reducing time perception. And also, that the congruence between the virtual aroma and the product would be potentialize the influence of digital scent.

1.5 Research objectives

General objective:

To explore whether, in the case of a digital scent technological solution, there would be an influence on consumer intention, behavior and perceptions.

Specific objectives:

1- To identify whether a digital scent has an influence on consumer attitudes and/or choice behavior.
2- To investigate whether congruence increases the influence on consumer intention and/or choice behavior in the case of a stimulating food-related fragrance.
3- To verify if there would be an impact on eating behavior with a calming non-food-related digital scent.
4- To identify if a calming non-food-related digital scent would affect the consumer's concentration and time perception.
5- To determine whether, in the case of a calming non-food-related scent, with lavender and talcum notes, if congruence would increase the influence of the digital scent on the consumer's choice and behavior.

PART 2

"Why it's simply impassible!
Alice: Why, don't you mean impossible?
Door: No, I do mean impassible.
(chuckles) Nothing's impossible!"

Lewis Carroll

2 THEORETICAL BACKGROUNDS

The theoretical framework begins with an exploration of how olfaction works biologically and psychologically to verify new ways to access the olfactory system without exposure to chemical odors. Once the goal of this study is to explore a digital scent possibility, we looked at the medical and psychological literature to have a better understanding of the selected technology mechanism and its influence on consumer behavior. We also present some historical milestones, concepts, and theories that guide the research structure.

2.1. The human sense of smell

While it is not the purpose of this study to enter the fields of medicine or psychology, it is necessary to visit both to better understand how the chemical sense of smell works and to identify other ways to "smell". Khishna (2012) adds that marketing, in particular, needs to know what sensations and perceptions scents can evoke in consumers so that they can be consciously adopted.

> As we know, sensation and perception are stages in the processing of the senses. Sensation is when the stimulus affects the receptor cells of a sensory organ - it's biochemical (and neurological) in nature. Perception is the awareness or understanding of sensory information" (Krishna, 2012, p. 334).

In other words, marketing also needs to understand how an odor's associations are created for the individual and what influences this perception on both a biological and psychological level. In previous studies, smell has been described as a priming agent capable of influencing consumers' behavioral, cognitive and affective responses to products, brands and environments, regulated by an unconscious mechanism involving automatic cognitive processes, i.e. those that occur without necessarily being perceived by the individual (De Luca & Botelho, 2021).

2.2.1 The Physiology of Smell

Biologically, the sense of smell can be accessed through the mouth and nose, where there is an olfactory neuroepithelium, a tissue with a high concentration of transmitter nerves that are activated by chemical stimuli (nanoparticles) that are the odors. When the odor is captured through the nostrils, it is known as orthonasal olfaction, and when it is accessed through the nasopharynx (nasal cavity at the end of the mouth), it is known as retronasal olfaction (Patel & Pinto, 2013; Spence, 2015). After being captured by the olfactory epithelium, there is a connection to the brain made by the axons (conduction of impulses) of these olfactory neurons, which form olfactory cues (nerve bundles) that make synapses in the central nervous system so that an odor can be decoded or learned (Gottfried, 2006; Patel & Pinto, 2013).

Smell is traditionally considered a chemical sense. Like taste, it is activated by chemical particles. Thus, due to the characteristics of activation and the proximity between smell and taste, the influence of aroma on the perception of taste is now more widely accepted. However, due to its complexity and ramifications, an odor can influence many aspects of the individual and also interfere with the perception of situations, products, environments and even people (Gottfried, 2006; Patel & Pinto, 2013).

In terms of olfactory physiology, the highest concentration of olfactory neurons is located in the mid-frontal part of the brain, close to the location of the limbic system. For this reason (Gottfried, 2006; Patel & Pinto, 2013; Olofsson et al., 2017; Niedenthal et al., 2021), there is a presumed connection between smell and memory, mood, associative learning, and emotion. Thus, olfactory ability can be altered by shocks or injuries to this cranial site.

2.2.1.1 Olfactory Influencing Variables

A major difficulty in identifying odor perception has been described as the number of variables that can influence this process, which also depends on the individual's context (Doucé et al., 2015; Koubaa & Eleush, 2020; Véga-Gómez et al., 2021). Some of the most frequently mentioned in previous studies are:

i. Gender: Males and females would perceive odors differently, either in terms of association or intensity. Females would be able to perceive the odor more accurately without the help of

other senses such as sight, touch, or hearing (Doty et al., 1974; Ellen & Bone, 1998; Doucé et al., 2015);
ii. ii. Respiratory syndromes: may be influenza and/or smoking;
iii. iii. Pregnancy and lactation: hormonal fluctuations disrupt the olfactory cueing phase;
iv. iv. Beta-blockers and anxiolytics: chemical substances that interfere with the activity of the central nervous system (Gaby & Tepper, 2020).

There are other sources of olfactory limitations. Olofsson et al. (2017) and Majid (2020) suggest that 2% of the global adult population has problems with olfactory perception, with greater losses after the age of 65 (Ornati & Kalbaska, 2022; Doucé, 2022; Bochicchio et al., 2023). More recently, active exposure to the COVID-19 virus has also been shown to affect olfactory perception (Spadera et al., 2022; Dal Bò et al., 2022).

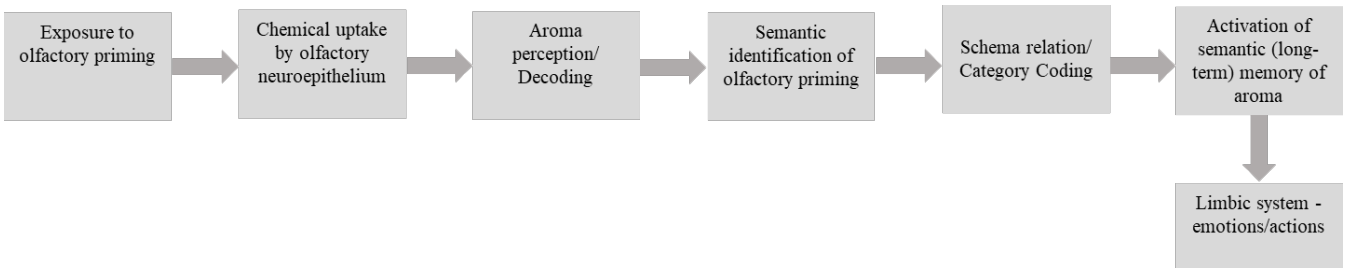
It is important to note that a lack of olfactory perception or altered odor identification affects various aspects of people's lives, such as taste, interpersonal relationships, emotional balance, psychological aspects (e.g., depression, irritability), and even physical safety (due to the inability to identify dangerous situations), such as the smell of fire or altered food (Stenslund 2015; Olofsson et al., 2017; Gaby & Tepper, 2020; Niedenthal et al., 2021). For this reason, finding ways to restore odor perception without the need to capture chemical particles or the presence of the odor source has motivated research and development of new technologies that can be adopted by marketing.

2.2.2 Olfactory Cognitive Aspects

In addition to the aspects of influence, we need to consider the connection between odor and the limbic system, which is responsible for the individual's responses and patterns and how they respond to stimuli (priming). An interesting starting point is to understand that in order to generate a response, an odor must be identified or associated with a long-term memory (Engen & Ross, 1973). Picking up an odor and "storing" it in memory can be considered an unintentional, involuntary memory, which means that it doesn't necessarily have to be trained or repeated many times to move from short-term to long-term memory. In other words, it is possible to remember an odor and its association without consciously intending to do so (Istomina, 1977; Neufeld & Stein, 2001).

On the other hand, it is also possible to "memorize" an aroma, to "educate" it in a way, through the experience with which it can be associated and/or through association with references from other senses (Herz, 2004; Majid, 2020; Olofsson et al., 2020; Labrecque, 2021). And although the olfactory process involves many biological steps, it takes place in a fraction of a second. Its influence can be prolonged by exposure to the odor or by the emotions associated with an activated memory. And this process causes the limbic system to promote an action (Figure 1).

Figure 1: Proposed model of the functioning of the olfactory system



Source: Adapted by the author from the Tulving model (1982) with elements from Zald (2000), Gottfried (2006); Patel & Pinto (2013).

What makes smell relevant to marketing is its ability to stimulate a response. Understanding the influences and expected associations of an odor is important in order to use it intentionally in strategies. This includes identifying ways to digitally access the sensation or perception of an odor without the need for the source to be present or chemically captured. If such a possibility exists, it is necessary to understand whether the introduction of "virtual scents" would influence consumer behavior.

2.2.2.1 Olfaction-Related Cognitive Theories

Although much of this study is based on identifying and verifying the influence of a digital olfactory solution on consumer behavior, in order to identify the best technological possibility, it is important to understand the mechanics of olfaction. In this sense, we identified cognitive psychology as a possible anchor for the development of digital olfactory marketing, since it is dedicated to understanding human behavior and mental processes.

In the field of memory research, there are three complementary theories that can be considered the basis of this study: the schema coding theory, originally presented by Bartlett (1932), the coding or content specificity model developed by Tulving (1982), and what can

be considered its evolution, the semantic priming and categorization theory (Tulving, 1986). In the first theory, in addition to storing information and experiences from the individual's context (world), memory must be associated with the meaning that the person assigns to this information. In other words, memories can be related to experiences and organized according to each person's conceptual schemes and familiarity (Bartlett, 1932; Schwartz & Reisberg, 1991; Neufeld & Stein, 2001). Therefore, "the basic units of processing would be schemas, which consist of 'packets of information' about generic concepts" (Pozo, 1998, p. 138).

For Neufeld and Stein (2001), Bartlett's (1932) schema theory can currently be considered constructivist, i.e. a memory can be stored from the perspective of both the events and the meaning that the individual attaches to them. The combined meanings can influence the assigned meaning. From this perspective, information and experiences from the outside world are organised around familiar conceptual schemes. These schemes include more static knowledge, such as about things and places. More dynamic knowledge, such as how facts occur in a particular event, is considered a script (Schwartz & Reisberg, 1991; Neufeld & Stein, 2001). Studies following this theory have found that memory is constructivist. Since it can store the most static/old events, dynamic events, as well as specific memories such as the interpretation and meaning attributed by the person, it was considered an evolution of Bartlett's original schema model (Neufeld & Stein, 2001). Following on from his study, Tulving (1986) shows that odours can be perceived according to a number of characteristics such as: i. familiarity (associations of the odour with something already known); ii. intensity (strong or weak); and iii. valence (pleasant/unpleasant).

Another important aspect is that olfactory memories can be both semantic and episodic, and in both cases, they can trigger an emotion or an action. The first would be long-term, which involves the categorization of linguistic terms, the definition of the memory and its relationship with the rules identified by the brain according to its socio-cultural context (Tulving, 1982; Neufeld & Stein, 2001; De Luca & Botelho, 2020; Majid, 2020), and for the aroma to be stored it must be named (Majid, 2020; Olofsson et al., 2020). The second, in turn, is associated with events, dynamic and sporadic situations. It should be emphasized that an episodic olfactory memory, for example, can become a semantic memory. What changes the situation is the ability to name and associate the odor.

Tulving's (1982) coding model also includes the concepts of recall and recognition. These are very relevant to the potential adoption of digital olfactory marketing. Recall would be the ability to name something from the past, and recognition would be a process of familiarity, i.e., remembering something already known without it being exactly the same (Neufeld & Stein, 2001). Once stored in long-term memory, these stimuli can be automatically and unconsciously triggered by olfactory priming. It is also important to emphasize that the expectation in this study is that the performance of a digital olfactory technology works on sensation and not on recognition of the odor through associative memory (Tulving, 1986; Neufeld & Stein, 2001). From this point of view, the digital olfactory stimulus could be considered as a semantic priming that can be expected to act automatically and instinctively by triggering olfactory memories (De Luca & Botelho, 2020).

In offline olfactory marketing, scent has been shown to have the ability to develop emotional and affective bonds between the brand and people, and can also promote attitudes. The point and opportunity of working with smells is that actions can be expected or not (Errajaa et al., 2021; Roxana & Ioan, 2013). In addition to the olfactory properties proposed by Tulving (1986), in the context of olfactory marketing, it is necessary to consider congruence (similar to familiarity), which can be translated as the synergy between the aroma and the product/service or between the smell and what the brand wants to convey. This would increase the ability of smell to influence consumer behavior (Tulving, 1986; Errajaa et al., 2021).

2.2.3 The influence of aroma

An aroma and its potential influence are not things that the brain can ignore. As previous research has shown, when an aroma is perceived and identified, even unconsciously, the responses are generally instinctive (Bradford & Desrochers, 2009; Eghil et al., 2010). This is due to the associations that each odor can have according to the culture, context and reality of the individual (Ferdenzi et al., 2016; Koubaa et al., 2020; Xiao et al., 2020). In this way, the responses obtained, both positive and negative, can be similar for a group and yet have different reactions for some people (De Luca & Botelho, 2020).

Because of these characteristics, the strategic use of fragrance in marketing has become something that needs to be evaluated in a structured way. Bone and Ellen (1999) present some aspects that need to be considered when selecting a fragrance for an environment or product, such as: i. Its presence; ii. Whether it is pleasant for the target audience; and iii. The congruence of the fragrance with the context in which it is used. Considering these aspects, olfactory marketing could have three main effects on the consumer: (1) developing affective and evaluative responses; (2) increasing purchase intentions and repeat visits; and (3) influencing time spent, task performance and/or the decision-making process.

Another important consideration is that the type of scent makes a big difference in what can be achieved as a response. So much so that olfactory marketing is exploring other ways in which scents can influence people beyond the perception of taste, quality, increased purchases and prolonged time in an offline environment. There are scents that can evoke a more exciting and stimulating response, such as coffee or citrus. Odors with elements that the limbic system can associate with issues of species preservation or reproduction (Tulving, 1986; Spangenberg et al., 1996) have a stimulating effect. In other words, it has been observed that fragrances related to food or pheromones have a more intense influence on the actions and perceptions of individuals (Doucé et al., 2015). However, there are also fragrances that can have a calming, soothing and inviting effect on the nervous system. Notes with elements of talc, flowers (such as roses and lavender), and wood would be examples of fragrances that have demonstrated this response in previous studies (Spangenberg et al., 1996). Calming scents are also associated with pleasantness and making people want to stay longer in a place, be closer, or reduce their stress levels (Tulving, 1986; Spangenberg et al., 1996).

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In other words, stimulating scents are associated with increased focus and attention, which favors activities that require concentration, such as driving or playing games. In contrast, calming scents promote relaxation and prolong time spent in environments, and have also been shown to be effective in situations that require patience, such as waiting in line. This distinction suggests that the strategic choice of fragrance can influence not only the consumer experience but also behavior in different contexts, highlighting the importance of matching the fragrance to the product or environment to maximize emotional and behavioral responses.

To analyze the development of olfactory marketing in the online reality, for example, another extremely important point is to examine the technological possibilities available to avoid the problem of having to detect and capture olfactory nanoparticles, which would not be possible in the virtual environment.

2.2.4 Digital scenting options

In the online environment, as is the case offline and due to technological limitations, the use of image processing to convey the perception of an odor is the most common (Petit et al., 2019). These visual primings could lead the person to activate the recognition of a long-term olfactory memory and thus adopt the schemas that would trigger the limbic system. Until then, this could be considered the closest thing to "scent in digital".

Research in Human-Machine Interaction (HMI) and cybernetics is based on the psychophysiological properties of olfaction to introduce interaction with olfactory stimuli virtually (via multimedia), in order to contribute to a sense of "reality", of immersion, even without the face-to-face factor (Murray et al., 2016; Olofsson et al., 2017; Petit et al., 2019; Spence, 2021; Niedenthal et al., 2021). However, by analyzing the studies, it was possible

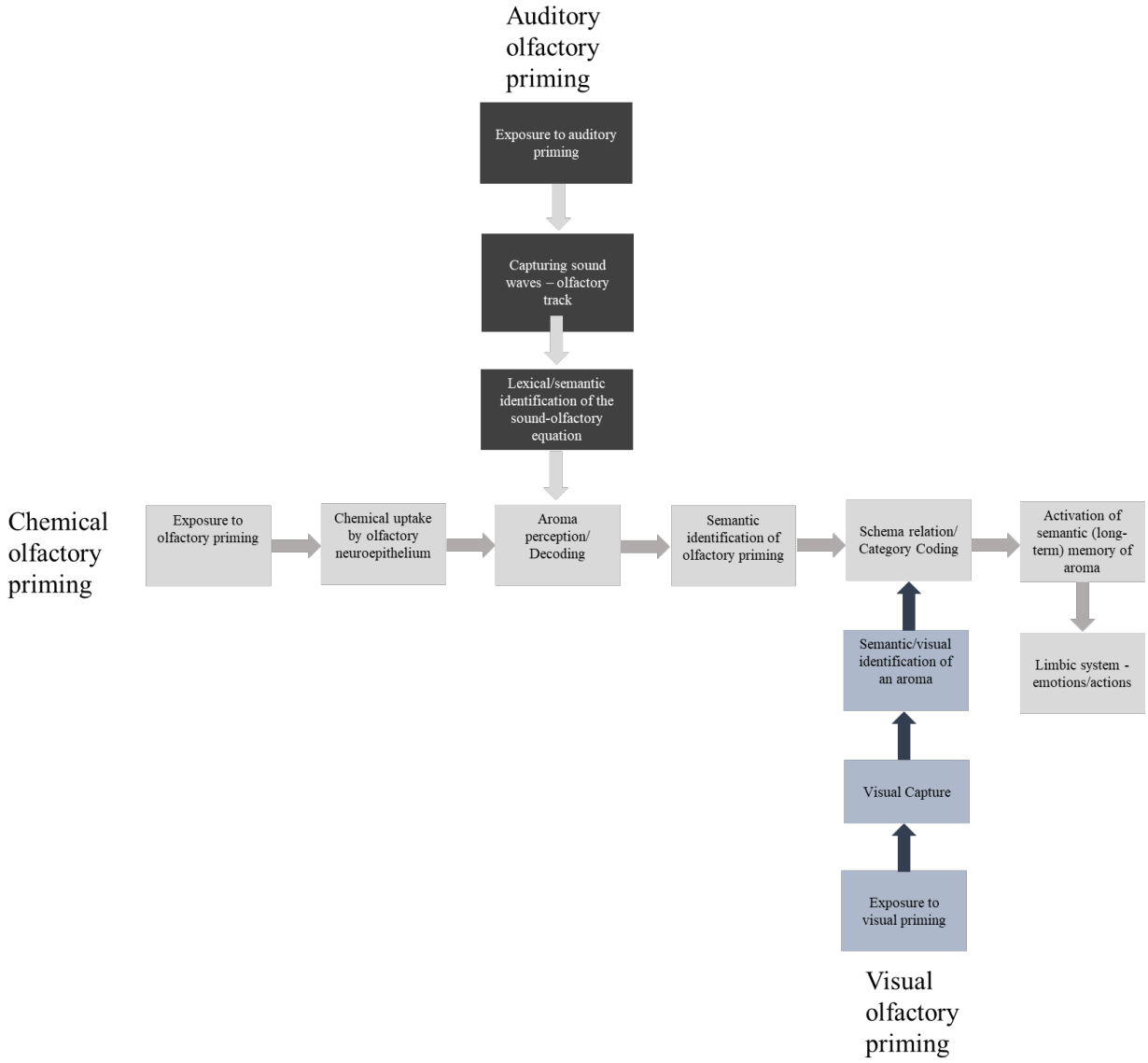
to identify advances in solutions that propose to access the olfactory system remotely or without accessing the chemical capture of the aroma.

In this exercise, it was possible to find some possibilities under development that could address the online reality. One of them was identified in the study by Niedenthal et al. (2021) called "Exerscent". This consists of a small device that can be used in the home, attached to a personal computer. Its mechanics use vibrations generated by radio waves that are picked up by a radio frequency identifier (RFID) connected to the computer. The goal is to retrain the brain to identify a radio frequency and associate it with a name or image of a scent. The researchers provided the file so that the device could be 3D printed.

Another possibility that has been mapped out is a technology called "scent by sound," which would convert sound waves into smells. Since it doesn't require a device, it is an inaudible "scent trail" that can be transmitted to any loudspeaker via MP3. Which, for online reality, seemed more appropriate. According to the developer, the tracks are equations that the nervous system could decode from a sound to a scent. Not by accessing the memory or schema of an odor, but by the sensation of the odor (Figure 2). These are sounds that are picked up by the axons (which conduct the impulses) of the olfactory neurons, which in turn form the olfactory rows that synapse with other neurons in the central nervous system, making it possible to smell (Patel & Pinto, 2013; Gottfried, 2006).

The technology was initially developed to provide the sense of smell to patients with loss of smell due to diseases such as cancer, degenerative diseases of the nervous system, and aging. However, the market potential was realized when it became possible to access the scent remotely and online, as the "olfactory tracks" (sound waves that make up each scent) could be made available on any technology that plays an MP3 file. In other words, since the senses are decoded in a single area of the central nervous system (almost like a decoding hub), the aroma equation, instead of being chemically captured by the olfactory neuroepithelium, would be accessed via the mechanical (auditory) sense, which has the same brain criteria for identification as an odor, thus stimulating the olfactory synapses instead of the auditory ones.

Figure 2: Proposed model of the Digital Olfactory functioning



Source: Adaptation of Tulving's model for digital olfaction (1982)

In order for this possibility of digital scenting to be considered by marketing, there are a few aspects that need to be taken into account. First, whether there is a perception of this stimulus. To do this, it is necessary to test this technology blindly (without the respondents knowing that they are being exposed) in order to measure its perception and possible effectiveness. A second point is to analyze whether the virtual sense of smell is capable of eliciting the same type of response as the chemical sense, in other words, whether it is capable of influencing the behavior and perception of individuals. In addition, given the complexity of olfactory perception in the human context, it is necessary to verify whether

the filters that interfere with chemical olfactory perception would have the same effect in the digital context.

With this opportunity, this study will investigate some possibilities: if the perception of the digital odor is verified, whether it is capable of influencing consumer behavior; if the digital olfactory priming, according to its nature, stimulating or reassuring, would produce different results in consumers. In addition, it is important to understand if the biological factors mentioned in the literature interfere in the case of a "virtual" odor and if their effect could be enhanced by congruence.

PART 3

"Sometimes I've believed as many as six impossible things before breakfast." – Lewis Carroll

Part III brings together the original articles that were written for this thesis and have already been presented above.

3.1 STRUCTURE OF STUDIES

This part presents the three main studies proposed to achieve the overall objectives of the thesis.

Article 1:

The first study is a systematic review of the literature that evaluates how previous research has explored olfactory marketing and seeks to identify the best ways to incorporate it into online marketing strategies. This review aims to provide a comprehensive overview of the existing research landscape, identifying key themes, trends and approaches in the field.

Article 2:

The purpose of this study was to test whether a digital scent would influence consumer intention and choice behavior. We also wanted to test whether contextual congruence would enhance the effect of an olfactory technology solution. We conducted a pre-test and two 2x1 experimental studies. To test the digital scent, the technology used in this research was Scent by Sound, scented with the coffee scent track.

Article 3:

For the final experiment, we chose a non-food calming scent with floral and talcum powder notes. This gave us the opportunity to test whether, in addition to potentially influencing behavior, a digital scent would interfere with the consumer's concentration and time perception. In addition, we needed to understand if there would be an enhancing effect of congruence between the digital fragrance and the product on the above relationships. Since this is an aroma that is not stimulant or associated with food, we felt that an important step in better interpreting the results of the individual laboratory sessions would be to conduct a field experiment with the dispersion of a chemical fragrance that has been evaluated as having the same characteristics as the olfactory track. This would allow us to compare the possible influence of the chemical odor versus the virtual one on food choice behavior. Thus,

our research included a brief literature review, two rounds of 2x1 laboratory experiments with the digital odor in individual collection, and two field experiments with the non-food calming fragrance accessing the chemical sense of smell, comparing two independent samples.

3.2 THE ARTICLES

ARTICLE 1

Paper submitted to the International Journal of Psychology and Marketing.

EXPLORING NEW FRONTIERS OF ONLINE OLFACTORY MARKETING

ABSTRACT

The main objective of this research is to analyze the possibilities of adopting online olfactory marketing. Secondary objectives are to identify possible mechanics of smell in the online context, determine how the physiological and cognitive olfactory system can work virtually, and explore the technological possibilities of commercial or online olfactory systems. We run a systematic review analyzes, with 90 multi-area theoretical and empirical studies that allowed us to identify five main research topics: the influence of aroma on behavior, aroma characteristics, differences in the individual, olfactory technologies, crossing of senses (multiple senses), and differences in the individual and respective olfactory relationships most studied in each theme. In addition, technological possibilities for accessing digital olfactory stimuli are discussed. Finally, we consider the ethical issues and propose a future research agenda.

Keywords

Olfactory Marketing; Online Olfactory Marketing; Systematic Review

1. INTRODUCTION

What if it were possible to smell the ocean while watching a video on the Internet? We discuss the possibility of accessing the olfactory senses without necessarily using the nose. Confusing? First, it appears that way. Although it has been challenging for several researchers from medical to cybernetical fields to develop alternatives for smell/taste/ and touch for lost situations or for re-education of access to the senses, the COVID-19 pandemic, with the lowdown and social detachment, demonstrated that these possibilities can also be useful for integration between brands and people (Gallese, 2020; Ornati & Kalbaska, 2022, Doucé, 2022). This increases the possibilities of online olfactory marketing.

In terms of offline sensorial marketing, for over five decades, studies have shown that the senses can influence consumers' experiences with brands, consumption behavior, and decisions. The sensations or at least the perception of these senses (Roxana & Ioan, 2013; Spence, 2015a; Krishna et al., 2016; krishna et al., 2017; Spence 2020 a,b), play a critical role in forming an atmosphere, which Kotler (1973) demonstrated to be capable of developing emotions and memories among consumers. To build this ambience with greater intention and a sense of hierarchy, the design of a brand's physical space with visual, auditory, olfactory, and tactile stimuli should promote immersive and intense experiences and a favorable long-term effect on the unconscious state of the individual (Lindstrom, 2012; Roxana& Ioan, 2013; Krishna et al., 2017; Spence, 2020 a,b; Busca et al., 2021; Charttejee, 2022). In the context of the pandemic, the increase in online demand and deprivation of the senses prompted the primary question: how would this "webmospherics" be developed in an environment where the senses are limited?

This study draws from the findings of previous studies concerning the influence of the olfactory in human behavior, evaluation and decisions (Bosmans, 2006; Zurawicki, 2010; Gorlich, 2015) and the findings on the olfactory marketing and market innovation in Charttejee's (2022) systematic review and Doucé 's (2022) editorial. Our study aims to deepen the possibilities of enabling online olfactory marketing. Though a systematic review following the recommendation of Palmatier et al. (2018) and Snyder (2019*)*, we evaluated 90 multi-area articles from 2015 to 2023 journals Q1 and Q2 from Google Scholar and Web of Science/Scopus bases, to identify the countries that have been studying the keywords: Digital "sensorial marketing," "Digital olfactory," Digital "olfactory marketing," Olfactory marketing

and Olfactory online—the most, the main authors, types of studies, and the most adopted methodologies. To support further studies and encourage other systematic reviews on the subject, as secondary objectives, we seek to identify possible mechanics of smell in this context, determine how the physiological and cognitive olfactory system can work virtually, and explore the technological possibilities of commercial or online olfactory systems.

2. THEORETICAL REFERENCE

The theoretical framework begins with a brief literature review of the olfaction functioning, the definition of olfactory marketing and its influence on consumer behavior. We also present some historical milestones, concepts and theories that guide the research structure.

2.1 How does the olfactory sense works

To further comprehend the possibilities of online olfactory marketing, the neurophysiological characteristics of olfaction must be understood. Ortonasal capture refers to the capture of aroma, fragrances, and odor through the nose, whereas retronasal olfaction refers to the capture of smell through the nasopharynx, which would be the nostrils at the end of the mouth (Patel & Pinto, 2013; Spence, 2021b). Some researchers are seeking to understand whether the undeniable connection between the chemical senses — taste and smell — is exclusively due to proximity or due to brain function (Patel & Pinto, 2013; Spence, 2015b; Spence, 2021b; Petit et al., 2021). After a sense is captured by the olfactory epithelia, the connection to the brain occurs by the axons (impulse conduction) of the olfactory neurons that form nerve bundles (olfactory rows), which then form synapses with other neurons of other senses in the central nervous system (Gottfried, 2006; Patel & Pinto, 2013). Consequently, an interconnection transpires between memory, mood, associative learning, emotions, and smell (Herz, 2004; Gottfried, 2006; Patel & Pinto, 2013; Olofsson et al., 2017, Majid, 2020; Labrecque, 2021; Petit et al., 2021; Niedenthal et al., 2021; Bochicchio et al., 2023).

Brain images from other studies revealed that odors, especially those that trigger Autobiographical Memories (AMs), can activate the amygdala- hypothalamus complex in the limbic system, which strongly activates emotional memory (Gottfried, 2006; Olofsson et al., 2017). This interconnection can generate automatic, emotional, or impulsive responses to an aroma (Engen & Ross, 1973; Lawless & Engen, 1977; Croy et al., 2014; Olofsson, 2014; Sandell, 2019).

A major part of olfactory function is directly associated with memory (Engen & Ross, 1973). The capture of the aroma and its "storage" in the memory can be considered an unintentional memory that does not require training or many repetitions to move from short-term to long-term memory. This movement occurs after the individual identifies the odor and associates it with other senses. After becoming a long-term memory, the recall of a smell or its association becomes an involuntary memory, in which it is possible to recall without a conscious effort to do so (Engen & Ross, 1973; Istomina, 1977; Neufeld & Stein, 2001; Olofsson et al., 2017; Sandell, 2019; Bochicchio et al., 2023). Therefore, the memory of a particular aroma can evoke positive or negative emotions and increase or decrease stress (Spence, 2015a; Krhisna & Schwarz, 2014; Zhong et al., 2022; Bochicchio et al., 2023).

Several theories exist about memories and the senses; however, regarding olfactive online marketing, two theories are considered as the basis: the schema encoding model, originally presented by Bartlett (1932), and the Encoding or Content Specificity model, elaborated by Tulving (1982). According to the first theory, memory, besides storing information and experiencing the context around the individual (world), must be associated with the meaning that the person attributes to this information. Thus, memory can be related to experiences and organized according to concept schemes and the familiarity of each person (Bartlett, 1932; Schwartz & Reisberg, 1991; Neufeld & Stein, 2001; De Luca & Botelho, 2020). Therefore, "the basic units of processing would be the schemas, which consist of 'packets of information' about generic concepts" (Pozo, 1998, p. 138).

In the second theory, memory is conceptualized as semantic and episodic, whereas the first theory is long-term and involves categorizing linguistic terms, defining the memory, and identifying the brain's norm rules (Tulving, 1982; Neufeld & Stein, 2001; De Luca & Botelho, 2020). Semantic memory concentrates contextual knowledge and must have the ability to be stored (Majid, 2020; Olfosson et al., 2020). Episodic memory is associated with events, autobiographical situations, and individual histories. This theory is also associated with recall and recognition. Remembering is the ability to identify something from the past, whereas recognition is a process of familiarity that can recall something previously encountered without being identical (Tulving, 1982; Neufeld & Stein, 2001).

Thus, these theories can be considered complementary. In the case of olfactory marketing online and how it can promote an attitude, a trigger by an odder sense would be required to access the memory of a specific aroma, which, based on the schema encode of that memory, would ignite the emotions related to a smell (Neufeld & Stein, 2001; Zald & Pardo, 2000; Herz, 2004; Gottfried, 2006; Croy et al., 2014; Oloffsson et al., 2017). This implies that the memory of a particular smell can evoke positive or negative emotions as well as increase or decrease stress depending on its decoding, thus promoting instinctive behavior. This leads us to another question: Can Olfactory Online also promote instinctive behaviors?

2.2 Olfactory marketing

Sensory marketing is gaining traction in offline reality as a means to attract and retain consumers in stores, enhance the shopping experience, and influence consumer behavior (Krishna, 2012; Basoc, 2015; Biswas & Szocs, 2019; Véga-Gómez et al., 2020; Krishna et al, 2021, Chatterjee, 2022). Systematic reviews, such as that of Chatterjee & Bryła (2022), Chatterjee (2022), and Doucé (2022), have unveiled that fragrance can improve various contexts, and it would be a trend to investigate how to make this possible online. To do so, aroma has some key or formative elements that must be considered: a) presence, b) pleasantness/familiarity, c) intensity, and d) congruence, the latter refers to the mental associations that consumers make between an aroma and its source (Véga-Gómez et al., 2020; Errajaa et al., 2021).

These characteristics determine the perception of a scent and are the ones brands manipulate to elicit more favorable consumer responses. As previously observed, Rimkute et al. (2016) and Véga-Gómez et al. (2020) confirmed that incorporating smell into the strategy has some benefits, namely: it is the only sense that cannot be consciously suppressed for an extended period of time; ii) it influences approximately 75% of human emotions on a regular basis (Engen & Ross, 1973; Doucé & Jansen, 1998; Lindstrom, 2012); iii) it allows individuals to access their subconscious and long-term memories and can influence 90% of instinctive reactions, mood, and consumer behavior (Engen & Ross, 1973; Lawless & Engen, 1977; Zurawicki, 2010; Véga-Gómez et al., 2020). These elements allow olfactory memories to have longer durations and be more resistant to interference after decoding. In this process, associations develop between smell and other senses and emotions.

The integration of senses is a factor that can also be analyzed strategically. For instance, the intensity of the smell, colors, and sound, as well as how they are combined in a multi-sensory immersion of the individual can either positively influence consumer behavior—in laboratory experiments and at point of sale, POS — (Doucé et al., 2016; Sandell, 2019a; Errajaa et al., 2020; Errajaa et al., 2021; Busca et al., 2021; Shahid et al., 2022; Roy & Singh, 2022, Spence, 2022) or create unpleasant emotions, stress, or senses overload (Lwin et al., 2016; Jang & Lee, 2019; Doucé & Adams, 2020; Dantec et al., 2022; Doucé, 2022).

2.3 Olfactory going digital

Living on the Web also means accessing our senses simultaneously, sometimes online and offline. In this perspective, the congruence/dissonance relationships of the senses (Rimkute et al., 2016; Krishna et al., 2017; Errajaa et al., 2021; Dantec et al., 2022; Abdolmohamad et al., 2022; Spence 2022) and the dominance (Jang & Lee, 2019; Doucé & Adams, 2020; Kaushik & Gokhale, 2021) related to the olfactory must be determined. For example, which would have a greater impact on online consumer behavior: a text about coffee or, if possible, the aroma of coffee (via technology)? Can we enhance perception or aroma through a system that permits activation by an audiovisual resource? What if the odor or aroma scheme was different from that of an image? Concerning the new technological possibilities (Petit et al., 2019, Niedenthal et al., 2021; Doucé, 2022) to enable the olfactory virtually (online), would this positively influence the online consumer experience? Will it have an additional effect on consumer behavior (in addition to visual or audio resources)? The schema encoding model for particular odors is cross-culturally applicable?

The COVID-19 pandemic is a global phenomenon that, in addition to posing biological challenges, has uncovered numerous vulnerable market niches. The segments that required "consumer presence" for the acquisition on a regular basis, such as those associated with the senses of smell and/or touch, began to seek opportunities to work as effectively as possible online despite several technological limitations (Covington et al., 2018; McMillan, 2021; Niedenthal et al., 2021; Nakanishi et al., 2022). With the advent of 4G, most Internet technologies have experienced a significant boost. Mobile access to the Internet, real-time connectivity, and immersive virtual technologies, such as Google Glass (a wearable technology) that, despite debuting in 2013, were initially targeted at the medical and manufacturing sectors. In 2015, academia and the market considered the possibility of virtual

reality as a wearable device that would enable consumers to feel completely immersed in virtual reality. To achieve complete immersion online, the senses must be combined as much as possible, at least including the olfactory senses (Murray et al., 2016; Olofsson et al., 2017; Spence et al., 2017; Covington, et al., 2018; Petit et al., 2019; Mehraliyev et al., 2020; Mishra et al., 2021; McMillan, 2021; Chatterjee, 2022; Nakanishi et al., 2022; Zhong et al., 2022; Panagiotakopoulos et al., 2022; Doucé, 2022).

Despite the fact that aroma can influence the perception of individuals offline in the academic community, examining this potential online application appears to be a limitation of previous studies and a recommendation for future research in the field of olfactory marketing (Crisinel et al, 2013; Lai, 2018; Petit et al., 2019; McMillan, 2021, Chatterjee, 2022, Panagiotakopoulos et al., 2022; Doucé, 2022). Due to a lack of technological means to test it online, the olfactory effect has been evaluated using videogames (Olofsson et al., 2017; Spence, 2021c) and remotely though model devices on labs (Murray et al., 2016; Spence et al., 2017; Lai, 2018; Petit et al., 2019; McMillan, 2021; Niedenthal et al., 2021; Nakanishi et al., 2022; Doucé, 2022). Some of the identified questions are as follows: How can we virtually access the sense of smell online? Will its influence be similar to those identified in offline reality studies? Is digital aroma accessed only through olfactory memory? How can formative elements of olfactory stimuli be performed digitally? The pursuit of possible answers to these questions prompted the creation of this systematic review, which considers the possibility of digital olfactory marketing.

2.4 Olfactory marketing online

We observed that consumers frequently connect and interact online over longer periods. More than 63% of the world's population is already online and spends an average of 6:53 hours of a day on the Internet (WE ARE SOCIAL REPORT, 2022). This demonstrates the opportunity to represent online marketing. According to some authors, it would be easier for a brand to develop a closer relationship with the consumer and strengthen ties online (Spence et al., 2017; Petit et al., 2019; Spence, 2021c). In addition, on the Internet, the correct access of the senses and the experience of the "“webmospherics” " would influence the behavior and savviness of consumers in developing these relationships with brands online. It is not something that only works for products, and a sensorial online experience would create a different segment as well (Murray et al., 2016; Krhisna et al., 2017; Petit et al., 2019; Spence,

2020a; Spence et al., 2020b; Spence, 2021c). Vision and hearing are the only truly accessible senses in online reality; however, through audiovisual resources, brands would attempt to stimulate the other senses, such as olfactory, taste, and touch. Developing an online olfactory system would amplify the possibilities of accessing the limbic system. This access can be achieved by: i. some tech solutions, such as by radio, electrical, dispersion, or audio waves (Urdea et al., 2021, Mishra et al., 2021; McMillan, 2021; Niedenthal et al., 2021; Nakanishi et al., 2022; Doucé, 2022); ii. an aroma schema encoding to stimulate instinctive responses (Velasco et al., 2018; Petit et al., 2019; De Luca, Botelho, 2020; Urdea et al., 2021, McMillan, 2021; Niedenthal et al., 2021; Nakanishi et al., 2022; Doucé, 2022; Bhardwaj et al., 2021), iii. olfactory memories can be triggered by recall of another situation or emotion (Engen & Ross, 1973; Lawless & Engen, 1977; Tulving, 1982; Neufeld & Stein, 2001; Herz, 2004; Krishna et al., 2016; Meng et al., 2021, Zhong et al., 2022; Bochicchio et al., 2023); or by association with other senses (Herz, 2004; Majid, 2020; Olofsson et al., 2020; Niedenthal et al., 2021).

Some technologies were developed with the aim of olfactory rehabilitation or restoring access to smells after medical trauma (Obrist et al., 2014). However, these technologies still require their own devices, tablets, or devices for access (Olofsson et al., 2017; Covington et al., 2021; Nakanishi et al., 2022; Doucé, 2022). Thus, technologies that would not be the first choice for the online environment would still undergo chemical physiology of smell (Spence et al., 2017; Oloffsson et al., 2017; McMillan, 2021; Nakanishi et al., 2022).

For olfactory online marketing, the technology should ideally allow remote sharing and communication of the aroma, thereby improving the consumer experience, supporting online purchase decisions, and interfering with mood in relation to a brand or digital content, regardless of the location of access (Obrist et al., 2014; Olofsson et al., 2017; Spence et al., 2017; Spence 2020d; Spence, 2021; Niedenthal et al., 2021; Spence, 2022; Doucé, 2022).

3. METHODOLOGY

This study is a systematic review of the literature according to the recommendations of Palmatier et al. (2018) and Snyder (2019), which recommend the following steps: 1) topic formulation, 2) research/study design, 3) sampling, 4) data collection, and 5) data analysis. Ensuring that these steps were clear, coherent, and replicable is imperative. This study aimed

to evaluate how previous research considered the possibility of including olfactory sensory stimuli (OSS) in online marketing strategies (Step -1). To debug this universe, databases of articles from Google Scholar and Web of Science/Scopus (CAPES journal base) were selected. The key words identified in the design of this study were: “olfactory marketing online,” “olfactory marketing,” “digital olfactory marketing,” “olfactory online” and “digital olfactory.” The criteria for selecting the sample are listed in Table 1.

Table 1: Filters for data selection and number of articles

Filter	Stage of data selection	N
Step – 2	Availability of articles in full on these platforms and in English	581
Step – 3	Peer reviewed	536
Step -4	Selection of papers considering the relevance/reach filter of the journals, considering a Qualis index of Q1 and Q2 in the SCImago Journal Rank (SJR)	289
Step -5	Selection time range from 2015 to 2023—especially empirical studies on the key word "Digital olfactory" at the Web of Science base starts at 2017	168
Step -6	Availability of the articles in full on these platforms and in English—excluding papers in oriental language	157
Step -7	Review of abstracts and introductions of the articles related to the research theme	90

* Search strings used: Digital "olfactory marketing", “online olfactory marketing,” “olfactory marketing,” “digital olfactory marketing,” “olfactory online,” and “digital olfactory” (also including plurals).
Note. Search was performed in the Web of Science/Scopus and Google Scholar databases until March 2023.
Source: Authors (2023)

The analysis process for the creation of themes included the creation of comparison tables of all text elements, namely: dependent and independent variables, analysis method, control variables or other variables. In addition, main results, theoretical essays and future research were separated. After this extensive tabulation, the data were crossed by 2 researchers in order to find common themes. And, in this way, the evaluation axes emerged from the review. We considered 90 articles that addressed the main theme of this review or issues related to its application, such as medicine, psychology, and human-computer integration (HCI). In addition, it was analyzed in some older research or studies in other languages referenced as “key publications” for understanding regarding “olfactory shopping atmosphere,” “olfactory marketing,” and “olfactory influence,” as mentioned in previous reviews, such as Chatterjee (2022); Chatterjee & Bryla (2022), with over 184 articles. Furthermore, several books, such as “Brand Sense,” Lindstrom (2012); “Handbook of Psychology of Aging, Lawless & Engen (1977); “Remembering: A study in experimental and social psychology,” Bartlett (1932); and

"Olfaction: Anatomy, physiology, and disease" by Patel & Pinto (2013), were considered. The tabulated articles covered the following: year of publication, authorship, abstract, theme/area, keywords, objectives, type of study, place of application, development context, possible influences, theories addressed, hypotheses, study variables, methodology, main findings, recommendations, and study limitations.

4. ANALYSIS AND RESULTS

We submitted the collected data for two analyses: descriptive and thematic analyses. The first identified bibliographic data helped in understanding the relevance of the theme, areas, and adhering journals, as well as the evolution of the area. The second identifies patterns and trends in the studies and main approaches.

4.1 Descriptive analysis

The ranking of journals that publish more theoretical and/or empirical studies on olfactory marketing and digital olfactory marketing is an interesting starting point for analysis. Despite the fact that it was a multi-area analysis, we adopted a pattern to consider only Q1 and Q2 journals (Table 2).

Table 2: Journals with the most published articles on olfactory marketing

Journal	IF	2015	2016	2017	2018	2019	2020	2021	2022	2023	N.
Sustainability	4.089						1	2	2		5
Frontier in Psychology	4.232				1		1	1	1		4
i-Perception	1.588						1	3			4
Journal of retailing	11.190			1		1		1			3
Food Quality and Preference Journals	6.345						2		1		3
Psychology and Marketing	2.939		1				2				3
Applied Science	2.838							3			3
Journal of Retailing and Consumer Services	4.219						2				2
IEEE sensors journal	3.301				1				1		2
Chemical Senses	3.157		1				1				2
Flavour and Fragrance Journal	2.576	3									2
European journal of marketing	1.483					2					2
Trends in Cognitive Sciences	24.482							1			1
Journal of marketing	7.461								1		1
Current Opinion in Psychology	6.813		1								1
International Journal of Contemporary Hospitality Management	6.514							1			1

Continue.

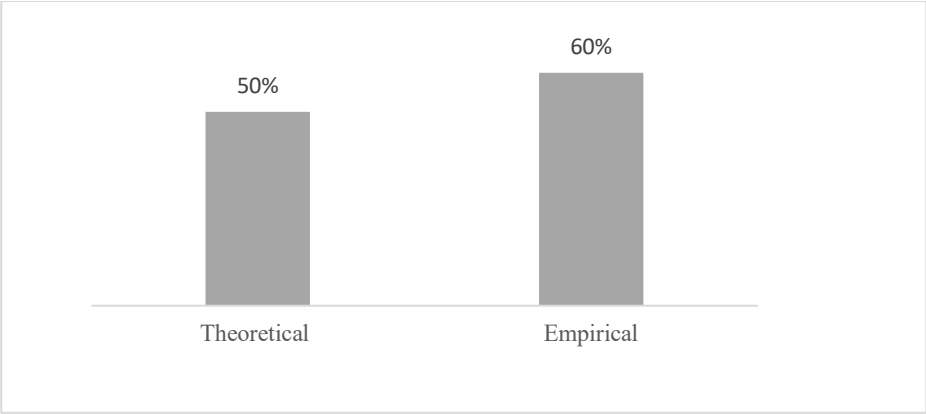
Continuation.						
Journal of Interactive Marketing	5.097			1		1
Creativity & Innov. Management	3.644				1	1
Creativity and Innovation Management	3.644				1	1
Journal of Product and Brand Management	1.832				1	1
Journal of Marketing Management	1.719			1		1
Sage Journal	1.356	1				1

* Only papers published until June 2022 were available at the time of this review. Other journals are ACM Computing Surveys, AIMS Agriculture and Food, AMV Review, and Cognitive Research: Principles and Implications, Int. J. Management Concepts and Philosophy; International Journal of Human-Computer Studies; Journal of Textile Design Research and Practice; M. Psychological Inquiry; Marketing Theory, Journal of the Association for Consumer Research; Marketing From Information to Decision journal; M. Psychological Inquiry; International Journal of Gastronomy and Food Science; Management Science Lett.; Journal of chemical engineering; The Senses and Society; MIT Sloan Management Review; Journal of Science and Technology of the Arts; Journal of the Association for Consumer Research; Technology and Culture; GEINTEC Magazine; Tourism Management; Journal of behavioral decision making; Molecules; Space and Society; Forum of Allergy & Rhinology; Transport Policy Journal; Journal of Affective Disorders; Journal of Service Management.

Regarding the data analysis of this systematic review, some articles have contextualized the unique reality of the COVID-19 pandemic from an olfactory marketing perspective, despite promoting a scenario of closed stores, people confined to their homes, it made it the online dynamic intensified (WE ARE SOCIAL REPORT, 2022). Papers concerning the marketing perspective of the impact of the virus were not that many. Meanwhile, in areas associated with HCI and health, some research addresses pandemic aspects at the physiological level of the individual, such as olfactory loss after viral contamination, olfactory loss as a symptom of contamination (Spadera et al., 2022), psychological effects of olfactory loss (Dal Bó et al., 2022; Bochicchio et al., 2023), and possible technological solutions to circumvent olfactory limitations and sequelae (Majid, 2020; McMillan, 2021; Niedental et al., 2021; Nakanshi et al., 2022; Panagiotakopoulos et al., 2022, Doucé, 2022).

The countries with the highest volume of publications, in order, are UK, France, and the USA, representing 49.4% of the publications related to the olfactory theme, and when analyzed from the perspective associated with digital olfaction, of the 10 studies, 5 are conducted in Europe. A balance was also observed in terms of the proportion of theoretical and empirical studies (Figure 1).

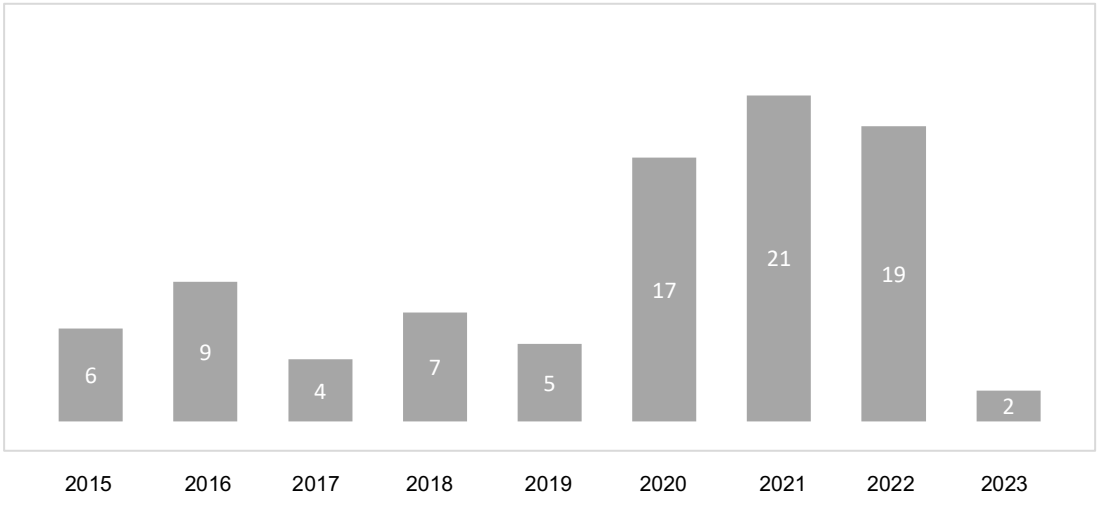
Figure 1: Studies proportions



Note: The difference from the theoretical and the empirical production is of 2 articles (43 empirical vs 47 theoretical). We could notice that in the area olfactory technology the volume is still limited.
Souce: Authors (2023)

We uncovered that until 2017, theoretical articles, which include themes regarding the analysis of empirical studies, market actions, new technological possibilities, systematic reviews of physiological and psychological theories of olfaction applied to marketing, and offline olfactory sensory marketing, were predominant (Figure 2).

Figure 2: Progression of annual olfactory sensory publications



Note: Volume of theoretical and empirical production per year in total. 2023 still opened.
Souce: Authors (2023)

Moreover, articles focusing on OSS in a digital context remain scarce as we can see below. In theoretical studies, themes concerning how olfaction works in different market areas, its influence on consumer experience, and consumer behavior remain predominant. In the

empirical articles, in addition to the predominance in the choice of experiments for studies associated with olfaction in the laboratory, it can be observed that an increasing number of articles seek to understand how aroma interacts in practice with offline and olfactory technologies. Regarding the themes, a concentration was observed in the areas that encompass the characteristics of aroma, its possible influences, how the olfactory sense interacts with others, individual characteristics of people, how they perceive and react to odors, and possible olfactory technologies. Further, we examined the most covered topics from theoretical and empirical perspectives.

4.2 theme analysis

Sensory marketing, particularly olfactory marketing, lays subjectivity and presents a numerous variable that can influence the process (Suominen et al., 2018; Spence, 2022; Chatterjee, 2022; Chatterjee & Bryla, 2022). For instance, according to studies on physiology and cognitive psychology, the olfactory can access memories and mental images (Aguillon-Hernandez et al., 2015; Herz, 2016; Errajaa et al., 2020; Majid, 2020; MENG et al. 2021; Dantec et al., 2022; Bochicchio et al., 2023), and the perception of an aroma can vary by factors, such as gender, age (Doucé et al., 2016; Meng et al., 2019; Kouba & Eleuch, 2020; Véga-Gómes et al., 2020, Doucé & Adams, 2020), and personal or bibliographic attributes of the individual (Busca et al., 2021; Sandell, 2019a; Majid, 2020; De Luca & Botelho, 2020; Kaushik & Gokhale, 2021).

That is, with individual differences, such as cultural issues, olfactory knowledge, and demographic aspects, the perception of aroma can vary and with that its reaction (Spence, 2015; Ferdenzi et al., 2016; Errajaa et al., 2020; Jang & Lee, 2021; Spence, 2022). Also representing an opportunity for enabling the online olfactory marketing is some researchers have studied how to train or develop new technologies to aid olfactory loss (Olofsson et al., 2017; Covington et al., 2018; Niedenthal et al., 2021).

Table 3: Thematic axes, subdivisions, and research methodological procedure

Thematic axis	No. of articles	Variables of interest	Descriptive of research	Some key references
Influence of the olfactory stimulus on consumer behavior	18 (12%)	Purchase intention Emotional reactions Quality perception Consumer preference Satisfaction Consumer experience Brand awareness Memory Decision-making	87% experiments, 13% descriptive	(shepard et al., 2015; Stenslund, 2015; Altamore, et al., 2018; Koehler et al. 2018); Darabi & Mirabi, 2018; Pereira, et al., 2019; Biswas & Szocs, 2019; Sandell, 2019B; Véga-Gómez, et al., 2020; De Luca & Botelho, 2020; Roschk & Hosseinpour, 2020; Berčík et al., 2021; Silva, et al., 2021; Meng et al., 2021; Abdolmohamad et al., 2022; Brengman et al, 2022; Shahid, et al., 2022; Bochicchio et al., 2023)
	36 (24,5%)		Theoretical	(Spence, 2015; Spence & Youssef, 2015; Petit et al. 2016; Murray et al., 2016; Rimkute et al., 2016; Krishna et al, 2016; Spence et al. 2017; Krishna et al., 2017; Krishna et al., 2017; Velasco et al., 2018; Suominen et al., 2018; Lai, 2018; Biswas, 2019; Petit et al., 2019; Labrecque, 2020; Spence et al., 2020; Spence, 2020a; Spence & Carvalho, 2020; Spence, 2020b; Spence 2020c; Spence, 2021a; Urdea et al., 2021; McMillan, 2021; Kaushik & Gokhale, 2021; Spence, 2021c; Girona-Ruíz et al., 2021; Purdy et al., 2021; Meng et al., 2021; Berčík et al., 2021; De Luca & Botelho, 2021; Spence, 2022; Stead et al. 2022; Chatterjee & Bryła, 2022; Panagiotakopoulos et al., 2022; Chatterjee, 2022; Bhardwaj et al.; 2023)
Characteristics of the olfactory stimulus	9 (6%)	Pleasantness Congruence Sympathy Online experience Olfactory company Intensity	83% experiments, 16% descriptive	(Doucé, et al., 2016; Sandell, 2019a; Errajaa et al., 2020; Errajaa, et al., 2021; Busca et al., 2021; Roy & Singh, 2022; Zhong et al., 2022; Bochicchio et al., 2023)
	30 (20%)		Theoretical	(Spence, 2015; Petit et al. 2016; Murray et al., 2016; Rimkute et al., 2016; Spence, et al. 2017; Khrisna et al., 2017; Krishna et al., 2017; Lai, 2018; Suominen et al., 2018; Biswas, 2019; Spence, 2020a; Spence et al., 2020; Spence, 2020b; Labrecque, 2020; Spence, **2020c;** Spence & Carvalho, 2020; Spence, 2021a; McMillan, 2021; Girona-Ruíz et al., 2021; Majid, 2021; Urdea et al 2021; Spence, 2021c; Campo et al., 2021; Meng et al., 2021; Berčík et al., 2021; De Luca & Botelho, 2021; Spence, 2022; Chatterjee & Bryła, 2022; Chatterjee, 2022; Ornati & Kalbaska, 2022)
Olfactory technologies	7 (5%)	Olfactory training Olfactory display pPods 3D AIR Olfactory Training/rehabilitation	83% experiments, 16% descriptive	(Olofsson, et al., 2017; Covington et al., 2018; Spence et al., 2020; Gaby & Tepper, 2020; Petit, et al., 2021; Niedenthal, et al., 2021)
	14 (9,5%)		Theoretical	(Spence & Youssef, 2015; Murray et al., 2016; Velasco et al., 2018; Lai, 2018; Spence et al. 2017; Petit et al., 2019; Urdea et al., 2021; McMillan, 2021; Spence, 2021c; Purdy et al., 2021; Kaushik & Gokhale, 2021; Spence, 2021e; Panagiotakopoulos et al., 2022; Chatterjee, 2022)
Multiple senses / sensory overload	5 (3,5%)	Smell and vision Smell, taste, and vision	80% experiments, 20% descriptive	(Lwin et al., 2016; Jang & Lee, 2019; Doucé & Adams, 2020; Spence, 2020; Majid, 2021; De Luca & Botelho, 2021; Dantec, et al., 2022; Doucé, 2022)
	17 (11,5%)		Theoretical	(Petit et al. 2016; Krishna et al., 2016; Velasco et al., 2018; Lai, 2018; Petit et al., 2019; Gallese, 2020; Spence et al., 2020; Spence, 2020b; De Luca, Botelho, 2020; Kaushik & Gokhale, 2021; Spence, 2021e; Campo et al., et al. 2022; Ornati & Kalbaska, 2022; Doucé, 2022; Panagiotakopoulos et al., 2022)

Thematic axis	No. of articles	Variables of interest	Descriptive of research	Some key references
Individual characteristics of olfactory perception	9 (6%)	Culture Familiarity Genre Ethnicity Age	100% experiments	(Shepard et al., 2015; RIMKUTE et al., 2016; Ferdenzi et al., 2016; Koubaa & Eleuch, 2020; Xiao et al., 2020; ZHONG et al, 2022; Spadera, 2022; Dal Bò et al., 2022; Bochicchio et al., 2023)
	12 (8%)		Theoretical	(Spence & Youssef, 2015; Khrisna et al., 2017; Lai, 2018; Biswas, 2019; Gallese, 2020; Labrecque, 2020; Spence & Carvalho, 2020; Spence, 2020a; Girona-Ruíz et al., 2021; Doucé, 2022; Bhardwaj et al.; 2023)

Source Authors (2023)

We proposed an order to analyze the identified themes, starting with the most recurrent themes in the studies. Considering the empirical research that focused on the influence of olfactory stimuli on consumer behavior, we could notice that there is a concern with the individual's experience in an environment according to two perspectives: first, how an aroma can influence the mood, emotions, development of affection (Krishna et al., 2017; Spence, 2021 and Shahid et al., 2022). Second, whether the olfactory can promote action in commercial and non-commercial sectors (Spence, 2015; Gorlich, 2015; Henshaw et al., 2016; Sandell, 2019b; Petit et al., 2019; Véga-Gomez et al., 2020; Urdea et al., 2021; Girona-Ruíz et al., 2021; Errajaa et al., 2021; Spence, 2022).

In offline research, consideration can also be given to determining whether aroma influences an individual's perception of the environment, the shopping atmosphere, the brand and the product or the service's characteristics, and how the aroma's formative elements (presence, pleasantness, coherence/congruence, and intensity) can be manipulated to achieve a strategic goal. The most researched aspects involve the interference of the aroma in the choice or decision of the consumer and how the memory of the smell can promote an action that may result in sales increase, brand recognition, brand satisfaction, or brand loyalty (Altamore et al., 2018; Xiao et al., 2020, Labreque, 2020; Busca et al., 2021; Berčík et al., 2021; Spence, 2021; Errajaa et al., 2021; Chatterjee, 2022; Shahid et al., 2022). We identified numerous possibilities for digital olfactory marketing. First, a better understanding of the possible outcomes of aroma influence, and second, how cognition can promote an olfactory experience even in the absence of the aroma source.

Vega-Gómez et al. (2020) and Errajaa et al. (2021) presented presence, pleasantness/familiarity, coherence/congruence, and intensity (which are associated with proximity to the source of the smell) as the formative elements of an aroma. The identification

of this element allowed us to understand that olfactory marketing must consider biological, physiological, and psychological aspects. In cognitive psychology, it can be identified how developed mental images are associated with an aroma or how to access these olfactory memories later through another sense (Aguillon-Hernandez et al., 2015; Herz, 2016; Errajaa et al., 2020; Majid, 2020; Meng et al., 2021; Dantec et al., 2022). Regarding this possibility, in the physiological process, it must be reinforced that the semantic/lexical decoding of an aroma is necessary to generate or access these olfactory memories (De Luca & Botelho, 2020), and the decoding process may be influenced by several subjective factors that can interfere with an individual's future response to a smell.

Taking the information derived from offline research and from the systematic review of Chatterjee as starting point for this study, where they could identify an olfactory influence on the consumer behavior, we consider that would be possible to achieve a similar influence of the olfactory online. Considering the olfactory and the we characteristics, we seek to identify studies that focused in comprehend the possibilities of olfactory training - to educate the olfactory thus other sense (Qiao et al., 2019) and researches that the goal was to develop digital olfactory technologies to recover or stimulate the access to the sense of smell).

Eventually, new research in the area of HCI in digital olfactory can provide additional alternatives. Panagiotakopoulos et al. (2022) proposed that digital smell technologies should be divided into those with chemical or electrical stimuli. Furthermore, this review identified new olfactory technologies that use radio waves (radiofrequency) and sound wave stimulation. The most verified methods are based on chemical stimuli that are available in four ways: natural vaporization, airflow (requires a fan), heating (smoke/gas generation), and atomization (production of particles on the basis of liquids). These involve the adoption of gadgets, having already been identified as preview attempts to develop a device by Olofsson et al. (2017), and others have been named by Spence et al. (2017), Covington et al., (2018), and McMillan (2021) but none of these were considered appropriate for a commercial scale. A new olfactory technology based on radiofrequency was developed in 2021, which proposes to re-educate and regain the olfactory sense after loss due to COVID-19 (Niedenthal et al., 2021). To date, we have not conducted any further tests using this device.

Considering that an individual is multi-sensorial and constantly exposed to more than one sense simultaneously, how the interaction between them occurs, how dominance works, and how to avoid sensory overload must be determined similarly when considering the online atmosphere and how it will interact with the offline surroundings. According to Krishna et al. (2017), the interaction of sensations is considered in the construction of consumer experiences that involve the senses (physiological aspects) and their perceptions (cognitive). Congruence/dissonance factors can interfere at the aroma influence, and the congruence between aroma and (mental) images can enhances the ability of the image or sound to influence in the human behavior (Busca et al., 2021).

However, in segments associated with the aspects of human reproduction (such as perfumes), incongruence has promoted more instinctive reactions (Doucé et al., 2016). Therefore, how to combine the senses according to the priority of their use must be understood, which Solomon (2016) enables us to determine to promote effective marketing. There also exists an indication regarding the relationship between the senses and the undesirable effect known as sensory overload, which occurs when there is a significant increase in neurocerebral stimulation (intensity of exposure to the senses on the same time) accompanied by a decrease in the perception of pleasantness and satisfaction (De Luca & Botelho, 2020; Doucé & Adams, 2020; Stead et al. 2022).

The possibility of individual interpretation of an aroma requires marketing to consider the environment, cultural context, the consumer's own moment of life (persona of the target audience), and personal/bibliographic attributes of individuals as aspects that may interfere with the associations of an odor with memory and possible reactions to it (Sandell, 2019A; Majid, 2020; De Luca & Botelho, 2020; Busca et al., 2021; Kaushik & Gokhale, 2021; Bhardwaj et al.; 2023). In studies related to this theme, it can be perceived how the decoding process occurs and how the ability to name a lexical or semantic smell may be induced by issues, such as gender, age (Doucé et al., 2016; Kouba et al., 2020; Véga-Gómes et al., 2020 Meng et al., 2021), ethnicity, and biological factors that may alter or compromise the ability to sense the aroma and increase the complexity level in the olfactory marketing (Spence, 2015; Ferdenzi et al., 2016; Errajaa et al., 2020; Jang & Lee, 2021; Spence, 2022).

An increase in studies in some macro areas was identified over time (see Table 4). In the area of the interaction between the senses and olfactory technologies, it has been demonstrated that, both in laboratory studies and field experiments, that scent influences human behavior in commercial and non-commercial sectors. Meanwhile, some studies have already focused on olfactory problems and the possibility of artificially accessing aroma, which is interesting for the existence of digital olfactory sensory stimulation for the online environment (webmospherics).

Table 4: Research volume per year

Olfactory macro area	2015	2016	2017	2018	2019	2020	2021	2022	2023
Influence of aroma on behavior	**1**			**2**	**4**	**3**	**2**	**3**	
Aroma characteristics		**1**			**1**	**2**	**2**	**2**	**1**
Olfactory technologies			**1**	**1**		**2**	**2**	**2**	
Crossing of senses (multiple senses / dominance / sensory overload)		**1**			**1**	**1**		**3**	
Differences in the individual		**1**				**2**		**2**	**1**
TOTAL	**1**	**3**	**1**	**3**	**6**	**10**	**6**	**12**	**2**

Note: Volume considering empirical studies.
Source Authors (2023)

We summarize the analysis/verification of main olfactory relation (Table 5).

Table 5: Main olfactory relation

Macro area	Main olfactory relation
Influence of aroma on behavior	**The influence of aroma in consumer attitude** (Bone & Ellen, 1999; Morrin & Ratneshwar, 2000; Zurawicki, 2010) **The influence of aroma on memory** (Engen & Ross, 1973; Kirk-Smith et al., 1983; Herz, 2004) **The influence of aroma on emotions** (Bosmans, 2006) **The influence of aroma in perception of an atmosphere** (Cox, 1967; Kotler, 1973) **The influence of aroma in the perceived quality** (Laird, 1932; Cox, 1967; Spangenberg et al.,1996) **The influence of aroma in the perceived mental image** (Bone & Ellen, 1999; Morrin & Ratneshwar, 2000)
Aroma characteristics	**Pleasantness or familiarity would be an essential feature for the identification of an aroma** (Bone & Ellen, 1999; Spangenberg et al.,1996; Morrin & Ratneshwar, 2000; Bosmans, 2006;)
	The intensity of aroma perception may influence its identification (Hirsch, 1990; Ayabe-Kanamura et al., 1998; Distel & Hudson, 2001)
	The congruence would be the individual's ability to associate an aroma with a mental image

	(Spangenberg et al.,1996; Bone & Ellen, 1999)
	As a chemical sense, it is necessarily the presence of the source of the aroma (Spangenberg et al.,1996; Bone & Ellen, 1999; Morrin & Ratneshwar, 2000)
	The aroma is associated with an olfactory long-term memory (Engen & Ross, 1973)
Crossing of senses (multiple senses / dominance / sensory overload)	**Integrated senses influence perception and behavior** (Hirsch, 1990; Spangenberg et al., 2005; Khisna et al., 2010)
	A dominant relationship exists between the senses (Hultén, 2004; Krishna, 2012)
	The senses can promote different emotions according to the integration between them (Classen et al., 1997; Greenberg, 2004)
	The combined senses in high intensity can generate sensory overload (Malhotra, 1984; Homburg et al., 2012; Spence et al., 2014)
Olfactory technologies	**The olfactory can be trained** (Baltes & Lindenberger, 1997; Qiao et al., 2019) **Smell can be re-educated with other senses** (Hummel et al., 1998; Bone & Ellen, 1999)
	Olfactory memories can be accessed by other senses (Engen & Ross, 1973)
	The neurological system can stimulate smell other than the nostrils (chemical presence) (Lawless & Engen, 1977; Morrin & Ratneshwar, 2000; Zald & pardo, 2000)
Differences in the individual	**The influence of age on aroma perception** (Larsson et al., 2000; Murphy, et al., 2004)
	The influence of gender on aroma perception (Gustavson et al., Dawson & Bonett, 1987; Spangenberg et al., 2005)
	The social group influences the perceived aroma (Fine, 1995: Ferdenzi et al. 2016)
	Location and culture can influence the perceived smell (Classen et al., 1994; Levitan, et al., 2014)

Note: Main elements studied in each macro according to the data analyzed in the article of this systematic review
Source Authors (2023)

As this study aimed to analyze how to enable an online olfactory marketing, besides de articles identified in this systematic review, we identified some others HCI possibilities that may develop a multisensory experience online with the Internet of Senses (Panagiotakopoulos et al., 2022). Some of these digital olfactory technologies has been studied in previous academical empirical research (Spence et al., 2017; Olofsson et al., 2017; Niedenthal et al., 2021; Nakanishi et al., 2022) and some of them are still in development and being tested (as the sound wave technology). We summarized the technological possibilities for accessing digital olfactory stimuli that we could identify so far on the table 6.

Table 6: Technological possibilities to access digital olfactory stimuli

Year	Author (s)	Type of technology	Functioning	Need of gadget	Digital test
2017	Olofsson et al.	Chemical – Atomization	An olfactometer integrated in the computer that presents odors to the subject.	Yes	Yes
2018	Covington, et al.	Chemical - Heating	Releases up to eight essential oils using a thermal mechanism. The unit contains a speed-controlled fan, temperature control, and a gas/smoke sensor to provide feedback and control the time and intensity of the aroma. It can be connected (via low-power Bluetooth) to a tablet/computer.	Yes	Yes
2020	Gaby & Tepper	Chemical - Airflow	qPODs with three different scents were used in others to determine whether people can identify the smell and the association or memory it may evoke.	Yes	No
2021	McMillan	Chemical – Atomization	AURA is a series of Internet of Things (IoT) connected, olfactory wearables that render sensor-captured data into digital scent display. It generates a database about how people react to an odor.	Yes	Yes
2021	Petit et al.	Olfactory memory – cognitive association	Visualizing served (vs. packaged) food in AR or 3D to promote mental simulation of eating experiences.	Yes	Yes
2021	Niedenthal et al.	Radio frequency	Development of the ***Exerscent***, a portable, low-cost olfactory display that can be operated with a personal computer, which includes Radio Frequency Identification (RFID) tags that are associated with some aroma stimuli and in a gamification system, that provide adaptive challenges for the user to identify the smells.	Yes	Yes
2022	Nakanishi et al.	Chemical – Atomization	The DSD ***Noar MultiScent 20*** is a digital scent device with a storage system for fragrance and can be used as a personal sniffer. Similar to a tablet, it controls the duration of odor release and generates a response database automatically.	Yes	Yes

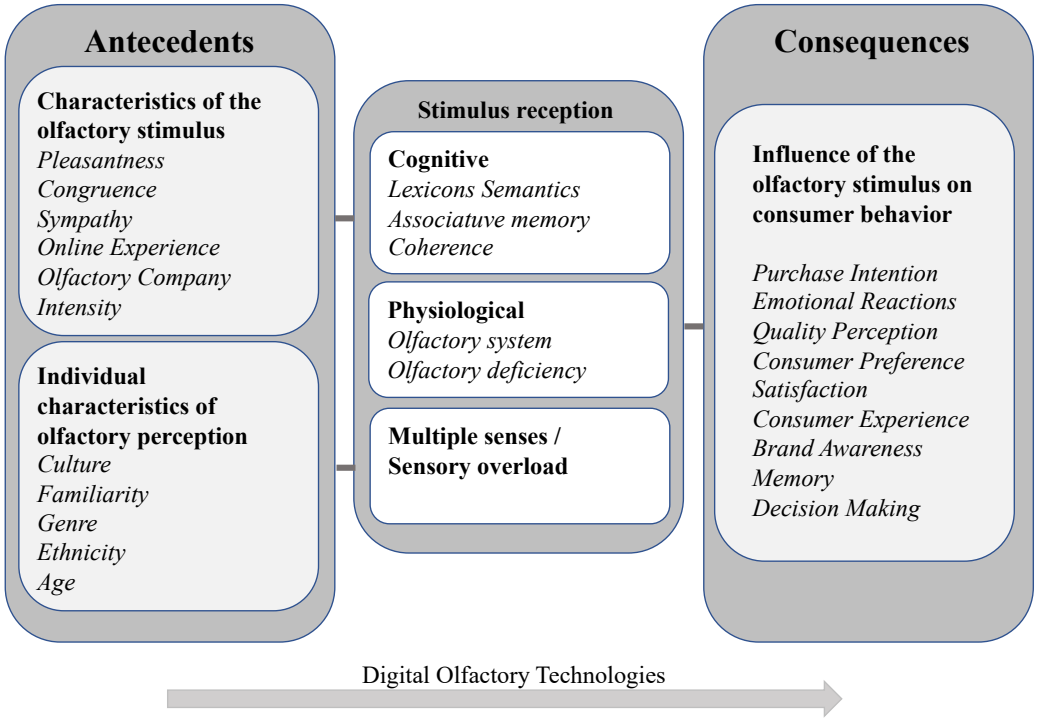
Note: Empirical studies.
Source Authors (2023)

Additionally, a technology in the field of neuro engineering, which is currently in the testing phase, aims to make aromas available using MP3. According to information provided by the company, The “Scents by Sounds” intends to use the encoding equations of aromas converted into inaudible sound waves that can be decoded as aromas by the nervous system. The development of technology began in 2019 as a possible treatment for patients with olfactory loss due to diseases, such as cancer, degenerative nervous system disorders, and age.

As discussed earlier in this review, activation of olfactory memories can occur through individual cognition. These possibilities have been adopted to develop a digital olfactory stimulus with sensory-enabling technologies, such as augmented reality, virtual reality, motion images, special photo treatment, and the use of sounds to activate the olfactory memories of smells through other senses (Petit et al., 2019; Xiao et al., 2020; Panagiotakopoulos et al. 2022). This process is centered on theories of cognitive psychology that study the associations of aroma with mental images and meanings. Thus, the reality of the individual and the culture that will interfere with the assignment of meaning to smell must be considered. This indicates that the image of melted cheese, for example, is associated with something capable of arousing hunger or has a negative connotation.

addressing the issues of olfactory and its influence on human behavior, the analyzed articles had themes that may be correlated. Through an analysis of the research approaches, we proposed a model (Figure 3) that illustrates the relationship between the issues and possibilities identified for implementing the online olfactory sensory marketing.

Figure 3: Online olfactory marketing model based on systematic review findings



Note: Possibilities do enable the online olfactive marketing considering the main variable identified in the articles.
Source: Authors (2023)

Similar to what occurs offline, online the implementation of olfactory marketing would be affected by an understanding of the process that the aroma undergoes from the physiological level, through its decoding, and ultimately eliciting a response from the individual (Spence, 2015a). The formative elements of olfaction, or olfactory priming, combine the biological and mental stages to the extent that, in the olfactory context, the process has neurochemical aspects and a stage involving a cognitive psychological perspective (Stenslund, 2015; Lwin et al., 2016; Olofsson et al., 2017; Koehler et al., 2018; De Luca & Botelho, 2020; Niedenthal et al., 2021; McMillan, 2021; Spence, 2022; Bochicchio et al. 2023). In the mental field, it involves the ability to identify and associate an aroma lexically or semantically, develop mental images and associations with the context (sociocultural), and maintain consistency between the source of the aroma and its associative memories, which can be of situations, emotions, or other senses (Stenslund, 2015; Lwin et al., 2016; Olofsson et al., 2017; Krisna et al., 2017; Spence et al., 2020d; Berčík et al., 2021; Busca et al., 2021; Meng et al., 2021; Doucé, 2022; Bhardwaj et al., 2023).

From a physiological perspective, that involves the action of chemical particles of smell on the limbic system, capable to promotes instinctive actions (Spence, 2015; Krishna et al., 2016; De Luca & Botelho, 2020; Girona-Ruíz et al., 2021). This access happens through short-term olfactory memories that "access the long-term stored ones." During this neural process, the authors noticed that genetic situations, diseases, trauma, and the use of neuroblocking substances (Gallese, 2020; Gaby & Tepper, 2020) hindered the connection between olfactory memories (triggered by the identification of nano chemical particles). Thus, the cognitive function of the aroma is compromised.

The researchers also tried to understand the olfactory loss process and its implications. In some cases, olfactory alterations may be temporary (cold, pregnancy, breastfeeding, respiratory diseases, or medications), but in others, permanent losses exist (brain trauma, age, and illnesses as cancer), where HCI and health research are effective in finding alternatives for activation, re-education, and access to olfaction. In such cases, training, learning, and retraining with another physiological sense can be involved; for example, to identify the aroma by memory (Lwin et al., 2016; Olofsson et al., 2017; Covington et al., 2018; Pereira et al., 2018; Spence et al., 2020; Gaby & Tepper, 2020; Gallese, 2020; Spadera et al., 2022; Dal Bò et al. 2022; Bochicchio et al.

2023), or the development of technologies that allows to actually smell or stimulate this possibility (Murray et al., 2016; Olofsson et al., 2017; Covington et al., 2018; Pereira et al., 2018; Velasco et al., 2018; Lai, 2018; Spence et al., 2020; McMillan, 2021; Niedenthal et al., 2021; Purdy et al., 2021; Doucé, 2022).

According to the Majid (2020), Spadera et al., (2022) and Dal Bò et al. (2022), in the context of the COVID-19 pandemic, many individuals exposed to the virus reported olfactory loss, causing loss of taste and even depression. Niedenthal et al. (2021) and McMillan (2021) developed solutions that would allow remote access to scents through technologies that can be used to augment the online olfactory marketing. Kaushik, Gokhale (2021), Chatterjee (2022) and Doucé (2022) believes that the pandemic has highlighted the need for marketing to consider new possibilities in the olfactory field due to olfactory loss at point of sale with the use of masks, and to encourage digital relationships. These authors analyzed the expectations of new solutions beyond audiovisual resources that can impact online consumer engagement.

Future research should seek new technologies that create a digital presence for aromas that could be adapted for the online olfactory marketing and consequently, the factors that can influence this application and if it has effects on consumer behavior online. Therefore, in this review, the authors' concern with possible moderating or mediating variables of the influence of olfactory stimuli known from offline studies, such as gender, age, and culture. This adds to the complexity of using OSS because, in addition to formative elements (intensity, pleasantness, and coherence), these variables are the most studied and that could have the greatest impact on the adoption of online olfactory marketing strategies. This raises the question of how to employ olfactory online and how to verify the intervention of these criteria in a breadth of reach, such as existing with the Internet, in the absence of a technology that is commercially suitable for online olfactory marketing (Spence et al., 2017; Doucé, 2022; Chatterjee, 2022).

4.3 Future agenda research

On the basis of the previous discussion and other knowledge gaps identified in our systematic review, we present an agenda for future research on digital olfactive marketing in Table 7. We organized these directions using five thematic axes, outlining ways to address these future

research questions. The purpose of this table is not to be exhaustive but rather to inspire new studies into the five proposed thematic axes.

Table 7: Future research opportunities

Thematic axis	Knowledge gaps and opportunities for future research
Influence of the olfactory stimulus on consumer behavior	a. Determine if the olfactory stimulus reproduces similar effects on the online experience, the quality of denial on websites and application contexts, in the digital environment. b. Studies on types of memory remain scarce. In the online environment, what is the effect on short-, medium-, and long-term memory? c. Investigate the effects of reinforcement and aversion of an aroma in an online environment. d. Mediation mechanisms in the online environment. Elements that can demonstrate the efficacy of the aroma effect and identify the role of humor as a mediator in aroma decoding and consumer evaluation. Map the influence of emotions on stimulus perception. g. Identify whether elements of cognition, such as creativity, can be trained to strengthen the individual's perception and, consequently, interfere in the decision-making process. h. Identify the ethical boundaries of aroma manipulation in the face of consumption behavior without their knowledge online.
Characteristics of the olfactory stimulus	a. Identify sources of aroma intensity that can positively and/or negatively affect consumption reactions. b. Identify the influence of the OEX scale (Company, Sympathy and Congruence) as formative elements of the olfactory stimulus.
Olfactory technologies	a. Comparatively test the use of technologies that stimulate the cognitive rather than the physiological system. b. Develop technological resources capable of controlling the intensity of digital aroma in an online environment. c. Investigate application of different technologies in different gadgets (e.g., cell phones, tables, and computers). d. Analyze the effectiveness of technologies applied in the metaverse.
Multiple senses/ sensory overload	a. Identify how the (in)congruence of stimuli can encourage decision making. b. Identify how learning and memory processes are affected by different combinations of stimuli. c. Identify how scent perception behaves in different immersive environments (e.g., metaverse)
Individual characteristics of olfactory perception	a. Identify age differences and gender predisposition to create aroma imagery. b. Analyze elements of social context and culture as moderators of the relationship between aroma and consumption evaluations. c. Understand inhibiting situations, such as permanent diseases or side effects, such as the cases reported after COVID-19.

Source: Authors (2023)

Considering technological developments, current gadgets involve expensive and uncomfortable equipment that do not facilitate the use of online proposals (Covington et al,

2018; Petit et al., 2019; McMillan, 2021; Doucé, 2022). Niedenthal et al. (2021) developed a technology that can be 3D printed with a free mold, but it would still be a device that trains an individual to recognize a scent virtually. Previous studies presented some solutions that require the inclusion of aromatic oils or aroma dispersers in the cartridges (Olofsson et al, 2017; Covington et al., 2018; Nakanishi et al. 2022). Another recurring question is to what extent the segment of the brand presented online, culture, and context of the individual can interfere with the possible effectiveness of a technology. Theoretically, it should have default intensity, coherence, and familiarity associated with the context in which the OSS was developed.

When analyzing the process of decoding a smell, there is a growing demand for cognitive mechanisms that imply image associations, memories, mental images, and an individual's imagination to interpret aroma. The purpose of this process was to trigger emotions and generate intuitive reactions. Thus, digital olfactory must exhaust the possibilities of online marketing implementation, test technological possibilities, and analyze possible interferences that can amplify or hinder the influence of smell on individuals.

According to Olofsson et al. (2017), Spence et al. (2017), and Spence (2021c), some attempts have not been operationalized or commercially accepted. Scratch-and-sniff cards and video games attempted to incorporate aroma into the multimedia experience, as did aroma-dispersion microphones and the OPhone, which released scents subtly via text messages and required users to lean in, as if smelling a flower. The challenges presented in these studies, with a focus on digital olfactory sensory marketing, have been twofold: to develop a technology that can effectively transmit aroma and how it adapts to formative elements, such as intensity and possible moderating variables, including age, gender, and culture.

Considering the complexity of human beings and the fact that we naturally receive an overload of stimuli, identifying effective combinations that can access positive olfactory memories remains a challenge. Moreover, a need persists to integrate it with other senses (multisensory immersion) to identify possible moderators that can interfere with the influence of olfactory stimuli in the digital environment on consumer perceptions and behaviors.

Regarding individual characteristics, emotions play an important role in olfactory influence. Beréunk et al. (2021) added that the type of emotions and feelings evoked by a scent can interfere with consumer behavior. Gaby & Tepper (2020) considered offline aroma dispersers and stated that an individual's mood and environment at the time of accessing an aroma influence the feelings triggered or developed. Therefore, in online reality studies, how the environment around an individual influences the perceptions, emotions, and reactions that the OSS can obtain must be determined. Busca, et al. (2021) realized that olfactory memories are triggered not only by vision (images) but also by imagination and individual's creativity. This finding may contribute to the proposal of possible adaptations to make digital scent available and to measure its effects.

Physiological, biological, psychological, and medical reactions can alter the effects of scents. Hunger, depression, some diseases, emotional state, medications, and the intensity of exposure in conjunction with other senses (sensory overload) have indicated the need to consider variables in studies on online olfactory marketing and, in other, more specific cases, to verify whether there is moderation or mediation of any of these factors in the relationship between the stimulus and the consumer's behavior, experience, or decision. Further, the differentiation between stimulus and digital olfactory must be explored, and how it should be integrated with vision and hearing without generating sensory overload when accessing a platform with several senses that are already highly dynamic (vision and hearing) must be determined. Specifically, the limit between the pleasantness of integration with other senses and the cause of discomfort in virtual environments must be determined.

In addition, future research should focus on differences in odor identification. Diverse interpretations of the stimulus or olfactory priming in the product and service segments have been generated by the offline culture and context of the individual. Thus, these interpretations within the broader realities of digital technology must be studied. Other aspects that require verification include variations in mental images or semantic meanings that a scent can have concerning commodities. Although these do not have many variations in odors and assigned meanings, is the inclusion of aroma perceived in the same way regardless of the person's culture and context? If identified, which scenarios promote consumer reactions? Would there be a transversal identification of a stimulus or priming, or is it necessary to map and analyze possible mediators and moderators in this relationship?

By analyzing previous studies on the online olfactory sensory marketing and the potential of digital smell, and of the Online Sensorial Stimuli, we concluded that a tendency exists to analyze the effects of smell on consumer behavior in various nuances, from odor identification to purchasing decisions. Therefore, a search for new olfactory technologies that are commercially available online is necessary. That is, verifying how the integration of accessible possibilities occurs to make the aroma available is critical (images such as augmented reality and 3D), and analyzing the relationship between congruence and dominance in multisensory integration is imperative. Due to the breadth and adaptability of digital, we recommend investigating potential differences between the use of digital scent by for-profit and non-profit brands. We also propose verifying whether the congruity of smell in digital olfactory sensory marketing influences the perception of individuals, and whether the quality, time, beauty, or size of what is being presented in the virtual environment.

Regarding methodological possibilities, we believe qualitative research, experiments, and questionnaires can provide stronger evidence for digital olfactory marketing. Qualitative research aims to understand consumer perceptions of the sensation of aroma (via technologies) or at the cognitive level (image processing and neurolinguistics). This can be achieved through experiments that evaluate these possibilities in laboratory and field environments. Therefore, there is an influence on the perception of other variables, such as the duration of exposure or the effect of other aromas, that can be used to confirm the possibility of mood-related variations in responses. To verify the answers in the virtual environment, the questionnaires were also associated with identifying the answers in this environment and verifying the possible interference of cultural aspects.

Another relevant form of testing in comparative studies is the assessment of biological and physiological aspects. For example, we can test technologies in the chemical field or those associated with vision (which can be the possibility of accessing olfactory memories via the cognitive pathway) using magnetic resonance. In case of resonance or auditory technologies, magnetoencephalography is used, which is a neuroimaging technology capable of demonstrating brain magnetic activity (Stringfixer, 2022). Another biological marker that can influence the perception of aroma is the stress level. Therefore, measuring this level

using a salivary sample before participating in the experiments can determine whether the digital environment (both when it involves technology and cognition) is influenced by cortisol (released by stress).

This systematic review verified the necessity of considering virtual reality as a parallel reality that can be strategically boosted through olfactory marketing. Thus, it is necessary to consider new technologies, other areas of knowledge, such as HCI or those presented by the medical and cognitive areas, and develop empirical studies that identify and analyze the effects of OSS in improving the online consumer experience, in obtaining satisfaction and building loyalty with the company on the Web.

4.4 Ethical issues

What types of actions can be considered ethically responsible in the context of olfactory marketing, particularly in virtual reality? How can we determine if something is safe for consumption, given that the sense of smell can trigger instinctive responses? If it is possible to access, either physiologically or cognitively, olfactory memories "without the individual's consent," how can one avoid being considered invasive or manipulative? When one can access either the unconscious or limbic system to generate instinctive reactions, the ethical limits of actions must be questioned. Spence (2015) demonstrated that the use of aroma in advertising campaigns at bus stops with a biscuit odor was halted because it was deemed harmful for people who were hungry and walked through that area, or who already had a problem with obesity, because the aroma of food can elicit feelings of hunger. This example shows the importance of having ethical criteria, or ideally, a code that predicts how far olfactory marketing can be used online and under what circumstances without prior authorization.

In the online context, the potential for action and damage is immense. The implication that, if fully remote olfactory technologies were developed, a consumer can be exposed to a scent via any Internet-connected device cannot be quantified at this time. In this case, how can people know whether they are exposed to a smell or if the images and sounds are manipulated for the cognitive system to associate them with olfactory memory? These processes can generate an instinctive reaction in which an online activity can motivate a need, desire, or choice in the individual without necessarily being aware of the person. Specifically, as

identified by researchers, such as Aguillon-Hernandez et al. (2015), Herz (2016); Koehler et al. (2018); Errajaa et al., (2020), Majid (2020), Meng et al. (2021); Dantec et al. (2022), Doucé (2022), smell provides direct access to limbic system reactions and, after decoding (by association with memories, semantics, and other senses), remains in memory longer, facilitating identification and recall, which makes it an intriguing marketing component. Thus, how to include it in digital sensory marketing must be considered, given that offline, when applied in stores, transportation, and environments, there is at least one chemical identification of the odor (Spence, 2015a; Spence et al. 2017; Spence ,2020c, Silva et al. 2021; Majid, 2020; Bochicchio et al., 2023), which would not be possible with fully virtual technologies.

5. CONCLUSION

Studies that examine the impact of olfactory stimuli on consumer behavior offline (or human behavior) have reached a consensus. Thus, we propose to verify additional aspects about this influence of aroma on behavior; for example, changes in perceptions about the quality of products, services, and brands (Altamore et al., 2018; Darabi & Mirabi, 2018; Biswas & Szocs, 2019; Jang & Lee, 2019; Sandell, 2019a; Sandell, 2019b; Véga-Gómez et al., 2020; Koubaa & Eleuch, 2020; Rodrigues et al, 2021), the notion of space—greater/smaller—changes, full/empty, elegant/basic lighting; about an environment—if there is interference from the environment, if it seems to be cleaner, calmer, or needs attention (Stenslund, 2015; Doucé et al., 2016; Henshaw et al., 2016; Altamore et al., 2018; Doucé & Adams, 2020; Spence 2020b; Roschk & Hosseinpour, 2020; Silva et al., 2021; Spence, 2021a; Spence, 2020b; Spence, 2021b, Doucé, 2022; Shahid et al., 2022). In the context of perceptions, it was possible to identify which emotional and cultural issues participated in the interpretation of smell and its assigned meaning in a more comprehensive way (Ferdenzi et al., 2016; De Luca & Botelho, 2020; Xiao et al., 2021; Dantec et al., 2022).

Despite that empirical studies of generalization are limited regarding the influence of OSS in different business segments, for gender and age, several opportunities exist to observe experiments conducted in the laboratory and field to work in congruence between the aroma and source or the brand; (Errajaa et al., 2021) as a possibility to optimize the result, and some situations in which dissonant smells, such as in segments that involve aspects associated with human reproduction, may have a more effective contribution (Doucé et al., 2016). Others

focus on analyzing the type of response that the aroma would be associated with its influence on other senses, such as taste, evaluating when adopted in the packaged or ready-to-serve food and beverage segment, the packaging presentation, and identifying food by smell (Spence & Youssef, 2015; Krishna et al., 2016; Krishna et al, 2017; Velasco et al., 2018; Altamore et al., 2018; Gaby & Tepper, 2020; Spence et al., 2020; Petit et al., 2021; Jang & Lee, 2021; Dantec et al., 2022).

Even in these seemingly remote contexts, the desire to investigate the mechanics and effect of smell for possible inclusion in the online segment to market products and services, improve the relationship with the brand, and reduce divergence in the interpretation of an aroma is evident (Lai, 2018; Spence et al., 2020b). When analyzing studies that seek to understand how to make digital smells available, some explore mechanical solutions that help consumers experience offline smell, whereas others are dedicated to conjecturing the possible influences of online adoption. When comparing studies that examine the context of olfactory marketing, there is an expectation of finding a technology that allows its adoption in the online physiological prism, and the search for parallel ways to access olfactory memories to activate the limbic system and obtain an effective response to the mark.

6. STUDY LIMITATIONS

This systematic review has some limitations that should be addressed in future studies. First, accessing studies with an olfactory sensory marketing bias in online reality is difficult. Part of this scarcity is due to technological limitations in the practical realization of these studies. In addition to being a meaning that has intensity as a formative element, which would be associated with proximity not characterized as being something appropriate in the online context, the subjectivity of the meanings and associations that a scent can have for different people also increases the complexity of the study in more general environments (in terms of amplitude), such as digital. The second is access to the content in its entirety within the database. Some articles in journals with a good rating that were inaccessible, preventing their inclusion in this study.

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ARTICLE 2

The first version of the article, with only the first collection, was presented at Enanpad 2023. Final version submitted to the International Journal of Research in Marketing.

DIGITAL AROMA: TESTING POSSIBILITIES FOR OLFACTORY MARKETING IN THE ONLINE ENVIRONMENT

ABSTRACT

The purpose of this study was to see if a digital scent would influence consumer intent and choice. We also wanted to see if contextual congruence would enhance the effect of an olfactory technology solution. To do this, we conducted a pre-test and two experimental studies. To test the digital scent, the technology used in this research was "Scent by Sound", which is designed to work by converting sound waves - called olfactory tracks - into scents. The main findings show that the digital scent can motivate consumer choice regardless of whether the context is congruent or not. We also analyzed the possible influences of elements that control olfactory perception through the chemical sense and elements that have been mentioned in the literature as forming an aroma. Finally, theoretical and managerial contributions are made and possibilities for future studies are presented.

Keywords

Digital Aroma; Online Olfactory Marketing; Consumer Behavior.

1. INTRODUCTION

The interest in carrying out this study was motivated by some factors that we identified in the marketing literature, with the potential to be a new area of study in the discipline: the influence of sensations on human behavior. Sensory marketing has been understood as having the advantage of being able to work with the human senses and influence people's perceptions and choices with a strategic objective (Krishna, 2012, Véga-Gómez et al., 2020). To this end, both academics and managers have signaled the importance of understanding how best to combine sensory elements to obtain an intentional response that is aligned with the brand, product or service objective for that moment. As we are multisensory, with more than one sense accessed at the same time, marketing needs to understand how best to associate them to generate a specific response (Lawless & Engen, 1977; Lovelock et al., 2011, Krishna et al., 2017; Doucé & Adams, 2020).

In these sensory studies, we have seen a growing interest in the influence of aroma on the response of individuals, and it has been identified that this is due to its own characteristics and psychophysiological action. Humans have the ability to identify and distinguish up to thousands of aromas and respond according to what that smell may be associated with in their memory (Engen & Ross, 1973; Spence et al., 2020; McGee, 2022). In previous studies, aroma has been shown to act on consumers' perception of quality in relation to brands (Altamore et al., 2018, Darabi & Mirabi. 2018), stimulating attitudes such as increasing the purchase intention or stay longer in a place (Krishna, 2012; Véga-Gómes et al., 2020), in the perception of the environment (Lai, 2018; Spence, 2020b; De Luca & Botelho, 2021; Spence, 2021a), the perception of taste (Spence & Yousef, 2015; Spence, 2015; Jang & Lee 2019; Petit et al., 2022) and as being able to access emotions (Herz, 2004; Bochicchio et al., 2023). Based on these results, we propose the following question: Since smell is originally a chemical sense, if there were a virtual olfactory possibility, would it have an influence on the individual?

This was the main research gap we wanted to analyze. To explore whether, in the case of a digital fragrance technological solution, there would be an influence on consumer intention and choice. When we looked at the potential of a digital fragrance for the web, we considered the need to analyze among possible proposals for technological solutions in the fields of medicine, human-computer integration (HCI) and cybernetics, so we could analyze which one would have a better fit for the online.

In addition, this study also aims to understand whether possible elements that have been shown to interfere with physiological olfaction, such as age, gender, use of medications that act on the central nervous system, pregnancy, lactation, head trauma, and exposure to COVID-19, would have an effect on a virtual aroma (Ellen & Bone, 1998; Croy et al., 2014; Chatterjee, 2022). Another related gap that could be tested was how the formative elements of aroma proposed by Véga-Gómez et al. (2020), which are originally related to physiological olfaction (chemical sense of smell), such as presence, congruence, intensity, familiarity, and pleasantness, could be integrated into the creation of a digital scent.

A third gap we identified in the offline research literature was the interference of congruence in the influence of aroma. In previous studies, when analyzing chemical olfaction, the product being congruent with the scent being studied would have shown a potentiating effect on consumer intention and behavior (Errajaa et al., 2020, Busca et al., 2020). Therefore, an additional challenge in this study is to test whether, in the case of a digital scent, the potential influence would be altered in different congruence contexts.

To verify these possible effects, we believe it would be more effective to start testing in neutral contexts, where digital olfactory technology would be able to motivate an action when there is no congruence between the scent and the product. As a further step in the study of olfactory possibilities with online potential, it was necessary to verify the possible influence of physiological elements that control olfactory perception and elements that have been reported in the literature to be aroma-forming (Véga-Gómez et al. 2020).

2. BACKGROUND

2.1 Sensory and olfactory marketing

Companies have recognized the importance of understanding what is capable of generating a cognitive, emotional and behavioral response from consumers to brands. Accessing the senses has been understood as a way to achieve better customer engagement and increase response. Based on previous studies, we have seen that retailers started to invest more in the presentation of the store, from the lighting to the aroma, with the aim of triggering a response from people, which could be anything from purchasing a product/service to consuming more or staying longer in the space (Kotler, 1973; Lindstrom, 2012; Lovelock et al., 2011, Solomon; 2016; Kotler & Keller, 2018). In offline reality, sensory immersion has been

shown to influence retail positioning and purchase intention (Lawless & Engen, 1977; Lovelock et al., 2011; Lindstrom, 2012) as well as consumer behavior and action (Doucé et al., 2016; Véga-Gómez et al., 2020).

The sense that has been regularly used in marketing to develop emotional bonds is smell, as it can more easily access the emotions and affections of consumers and their emotional memories (Engen & Ross, 1973; Lindstrom, 2012; Solomon, 2016; Bochicchio et al., 2023). Complementing this perspective, Olofsson et al. (2017), Petit et al. (2019), and Spence (2021) suggest that the importance of olfactory stimuli in on-the-go marketing strategies is due to their ability to generate immediate and instinctive reactions. Therefore, understanding how to generate these responses has become a trend in theoretical and empirical marketing studies (Panagiotakopoulos, 2022, Chatterjee, 2022; Abdolmohamad et al. 2022; Brengman et al. 2022).

When we looked at olfactory research that had more empirical characteristics - whether field or laboratory experiments - the limitation was the sensitivity of identifying the response to an aroma, as there were several variables that could potentially influence the sense of smell. In the offline studies, some possible control elements include biological interferences such as age and gender (Doty et al. 1974; Ellen & Bone, 1998; Croy et al., 2014; Chatterjee, 2022) or environmental and cultural differences (Ferdenzi et al., 2016; Koubaa et al. 2020; Xiao et al., 2020), which can be observed in some cross-cultural studies (Stenslund, 2015; Henshaw et al., 2016; Silva et al., 2021; Spence, 2021b).

However, when it comes to observing the influence of olfactory marketing in the digital environment, studies are still more limited (Petit et al., 2019; Brengman et al., 2022; Panagiotakopoulos et al., 2022; Chatterjee, 2022; Bhardwaj et al., 2023). In addition to the technological issue, an important point for studying the possibility of adopting a fragrance in the online environment is to know which of the formative elements of fragrance presented by Vega-Gómez et al. (2020) would adapt in this context. These would be: i. Presence; ii. Pleasantness; iii. Intensity; and iv. Congruence (mental association that the consumer makes linking the odor to the environment/source).

In other words, we need to understand how technology can overcome the challenge of

formative elements such as presence vs. virtuality, intensity vs. standardization in relation to a personal scent. In order to understand these points, we explored research in the fields of human-machine interaction (HMI), neurophysiology and cybernetics, which take the physiological characteristics of smell as a starting point and attempt to reproduce virtually (via multimedia) the interaction of chemical olfactory stimuli. In short, the opportunity to test one of the available technological solutions of digital scent offers the possibility to contribute to a broader sense of "reality", to be immersed in the online environment or metaverse, even if there's no physical presence (Spence et al., 2017; Olofsson et al., 2017; Petit et al., 2019; Spence, 2021; Chatterjee, 2022; Brengman et al. 2022). In order to understand how the potential virtual odors might work, we need to be familiar with the mechanism by which odor works, both physiologically and psychologically.

2.1.1. How the sense of smell works

While we don't intend to delve deeply into olfactory neurophysiology, we have looked to research in the medical and neurological fields to try to understand how the chemical sense of smell works, and therefore how a virtual sense of smell might work.

According to Patel and Pinto (2013), the olfactory system allows individuals to identify or verify both what is in their environment and what is in contact with their body. As it functions physiologically, the sense of smell is activated by chemical nanoparticles (the odor) that are captured by the neural accesses to the transmitting nerves (olfactory neuroepithelium), which can be orthonasal, which is access through the nose, or through the oral cavities, which is retronasal olfaction (Gottfried, 2006; Patel & Pinto; Spence, 2021a). After being received by the olfactory neuroepithelia, there is a connection to the brain by axons (conduction of impulses) that form nerve bundles (olfactory tract) that form synapses with other neurons in the central nervous system. At this stage, the captured odor passes through the decoding and learning area of the brain, which, depending on the associations of this odor and the individual's ability to identify it, causes an odor to pass from a short-term or episodic memory to a long-term olfactory memory (semantic memory) stored by the limbic system (Gottfried, 2006; Zurawicki, 2010; Patel & Pinto, 2013). In this sense, identifying an odor requires knowledge of the context associated with that odor for the individual and requires the ability to name/relate the odor so that it would be transformed into an olfactory semantic memory (Majid, 2021; Olofosson et al., 2020).

The highest concentration of olfactory neurons is located in the frontal lobe of the brain, where the limbic system is also located, which is why researchers in the fields of medicine and neurophysiology believe that there is a close connection between smell and memory, mood, associative learning, and emotion. So much so that trauma to this region has been shown to alter olfactory perception (Herz, 2004; Gottfried, 2006; Zurawicki, 2010; Patel & Pinto, 2013; Olofsson et al., 2017; Zhong et al., 2022). Brain images from other studies also show that smells, especially when they trigger AMs (autobiographical memories), activate the amygdala-hypothalamus complex to increase emotional memory activation (Gottfried, 2006; Olofsson, 2014; Olofsson et al., 2017). The memory of a particular scent can evoke positive or negative emotions, increase or decrease stress. This adds to the biological association of smell with emotion and mood.

Another important aspect that should be reinforced is the fact that olfactory awareness can be learned (Niedenthal et al., 2021). In other words, the sense of smell can be consciously "trained". Translated to marketing needs, this means that companies can work with scents in such a way that the individual identifies and decodes smells according to possible memorization (Herz, 2004; Gottfried, 2006; Olofsson, 2014; De Luca & Botelho, 2020; Zhong et al., 2022: Bochicchio et al., 2023). In other words, olfactory marketing would need to know the associations that a fragrance can have according to its target audience profile, so that brands can use smells strategically. The same need extends to the potential of digital scents.

In other words, memory plays a key role and can both influence and be influenced by olfactory perception. There are reports that the importance of smell for cognition goes so far that, in more serious cases such as olfactory loss, the inability to perceive a scent could lead to emotional disorders such as depression (Spadera et al., 2022; Dal Bò et al., 2022; Ornati & Kalbaska, 2022). Therefore, we believe that in addition to medical research, we need to understand olfaction through cognitive theories.

In psychology, two theories of memory have been identified that can be used as guidelines for this study: the schema coding model presented by Bartlett (1932) and the coding or content specificity model developed by Tulving (1982). In Bartlett's approach, in order to store information and experiences from the context around the individual (world), memory

must be associated with the meaning that the person assigns to this information, whether positive or negative. In the first theory, memory can be related to experiences and organized according to each person's conceptual schemes and familiarity (Bartlett, 1932; Neufeld & Stein, 2001).

In Tulving's (1982) model, memory would involve the categorization of linguistic terms to name an odor in order to define its association with the rules and norms identified by the brain (Neufeld & Stein, 2001; Krishna et al. 2017; De Luca & Botelho, 2020; Majid, 2021). The concepts of recall and recognition are also related to this concept. Where recall would be the ability to name something from the past, and recognition would be a process of familiarity that can recall something already known without it being exactly the same (Tulving, 1982; Neufeld & Stein, 2001; Bochicchio et al., 2023; Bhardwaj et al., 2023). This aspect of memory in the case of a digital scent can help us understand how olfactory memories are triggered and how they can evoke emotions without the capture of chemical nanoparticles.

These theories are somewhat complementary. A scent, or the memory of a scent, can develop mental schemas that activate affection and emotion, which in turn can influence the consumer's intention and decision-making process (Engen & Ross, 1973; Lawless & Engen, 1977; Bone & Ellen, 1999; Morrin & Ratneshwar, 2000; Shahid et al., 2022).

The literature also shows that olfactory perception is not the same for everyone. Gaby & Tepper (2020) point out that since the sense of smell is very sensitive to many variables in the environmental and individual context, it is necessary to first understand the aspects that may moderate the effectiveness of olfactory perception. In addition to the aforementioned criteria of age, gender and head trauma, the authors mention pregnancy or lactation, as well as the use of medications that act on the central nervous system (such as beta-blockers, antidepressants and anxiolytics). In addition, medical studies have also shown that COVID-19 is a significant factor (Ornati & Kalbaska, 2021; Spadera et al., 2022; Bochicchio et al., 2023). For Majid (2020) and Niedenthal et al. (2021), the loss of smell identified as a side effect of coronavirus contamination has even led to the development of technologies to retrain olfactory perception and gradually restore this ability (Niedenthal et al., 2021). During the first two months of exposure to the virus, the ability to detect or identify odors

would be more impaired, affecting the senses of smell and taste (Majid, 2020; Ornati & Kalbaska, 2021; Spadera et al., 2022).

In the case of testing a possible digital scent, it is necessary to know whether these aspects of interference in the physiological olfactory would also interfere in the possibility of a virtual scent. In other words, we need to verify them as control elements in this study.

2.2 Digital olfactory marketing technologies

For researchers such Brengman et al. (2022) and Nakanishi et al. (2022), it is a market trend to develop and introduce digital interaction technologies that would try to create an online shopping atmosphere capable of generating positive effects. These new technologies could simulate other sensory properties of a product such as texture, aroma and even taste. In other words, simulate senses that need the 'presence' dimension to be virtually accessed (Véga-Gómez et al., 2020).

Obrist et al. (2014, p. 2844) point out that "most work on Olfactory in the field of Human-Computer Integration (HCI) focuses on the development and evaluation of enhanced scent technologies. The kind of 'desirable smell technologies of the future'". In other words, HCI also seeks to develop solutions that enable the sharing and communication of scent remotely, applicable to different contexts such as remote events with family and friends, promoting the sensation of immersion, supporting decision-making in online product purchases, influencing with the mood towards a brand or online content and integrating olfactory sensory stimulation into various multimedia applications and the metaverse (Obrist et al. 2014; Murray, 2016; Olofsson et al., 2017; Petit et al. 2019; Panagiotakopoulos et al. 2022; Brengman et al., 2022).

The importance of overcoming the barrier of distance for olfactory sensory marketing has become even more evident with the social isolation promoted by the global pandemic. With the lockdown scenario and the subsequent social isolation, the contact between people and brands has taken place through the online reality, and some segments, especially those that needed olfactory and gustatory support, have been affected. The available SETs, mainly visual stimuli such as image processing, augmented and virtual reality, are the most widely used to access perceptions that are triggered by the memory of an odor, but without actually

being able to smell it (Petit et al. 2019; Brengman et al. 2022; Panagiotakopoulos et al. 2022; Chatterjee, 2022). The proposals for technologies that make smell virtually available that we have identified present different proposals: it could be done by dispersion (Olofsson et al. 2017; Covington at al., 2018; Gaby & Tepper, 2020; Nakanishi et al., 2022), by radio frequency via multimedia (Niedenthal et al. 2021; Spence, 2021), or by transforming a priming via another sense.

In this quest to make scent available remotely, some technologies have been announced. There was a radio wave device for the olfactory re-education after the loss caused by COVID-19 (Niedenthal et al., 2021). A proposal for dispersing scents via mobile devices that could be attached to a cell phone and also accessed with a tablet to promote a company's scents - Digital Scent Tech (Nakanishi et al., 2022) and a technology that has begun to be developed to restore the sense of smell in patients with olfactory loss due to diseases such as cancer, degenerative diseases of the sense of smell or age, which attempts to use inaudible sound waves (mechanical sense that accesses the limbic system) that allow the smell to be decoded: "Scents by sound".

The solution proposes to optimize the neurophysiology of smell and obtain olfactory synapses without the need to access orthonasal or retronasal chemical uptake (Spence, 2015). However, the market potential was realized because it allowed access to smell via "scent tracks" (sound waves that are converted into equations for the brain to identify each scent) that could be accessed on any technology that plays an MP3 file. The company agreed to provide the technology for the study.

2.3 Hypothesis development

2.3.1 Olfactory marketing

The relevance of the olfactory sense for marketing is due to certain characteristics, such as: in humans, it is the only sense that cannot be consciously overridden and is capable of influencing around 75% of the emotions experienced (Lindstrom, 2012). It remains in long-term memory due to its unconscious operating process, triggering emotional memories and the limbic system, which is responsible for generating instinctive and automatic responses, even without conscious perception (Lawless & Engen, 1977; Zurawicki, 2010; Shahid et al., 2022; Bhardwaj et al., 2023). In essence, the perception of aroma is capable of promoting

actions and provoking reactions in the consumer. Knowing that there are differences in the intention to buy and the actual act of buying, both possibilities have been studied in offline olfactory marketing and aroma has been shown to have the ability to influence both the mental field, the intention (the will to buy) and at the choice, the action of buying (Lovelock et al., 2011; Lindstrom, 2012, Doucé et al., 2016; Véga-Gómez et al., 2020; Bhardwaj et al., 2023).

However, authors such as Panagiotakopoulos et al. (2022), Doucé et al. (2022), and Chatterjee, (2022) suggest that it is still necessary to understand whether there is an influence of smell in an online context. Part of the challenge would be to adapt or overcome the unavailability of formative elements of smell such as presence and intensity in the virtual world (Véga-Gómez et al. 2020). The development of digital olfactory technologies would provide opportunities to make scent available virtually. Therefore, hypothesis 1 of this study could be proposed:

(H1a) The digital scent is able to positively influence the intention of the consumer.
(H1b) The digital scent is able to positively influence consumer´s choice.

2.3.2 Olfactory congruence and non-congruence

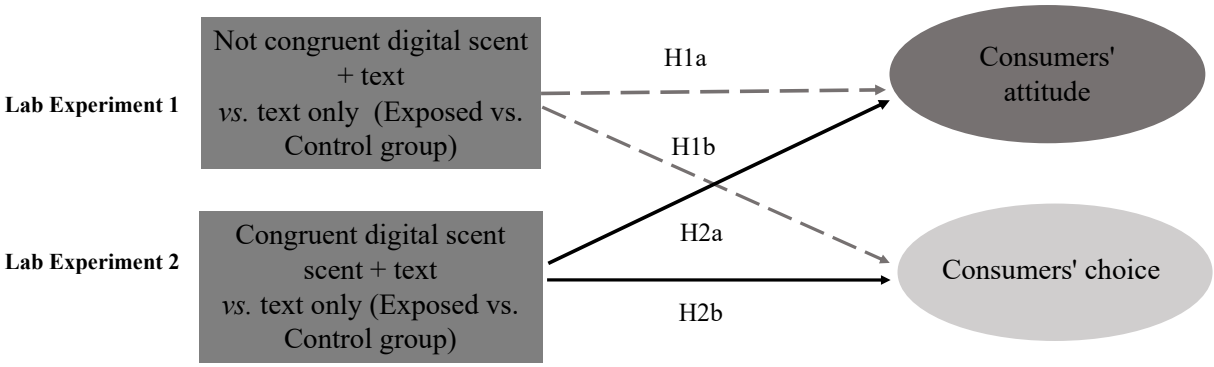
In previous offline olfactory studies, congruence was tested by associating the odor with an image or name that may or may not be related to the source of the smell. For example, the aroma of popcorn and the image or name corresponding to the aroma. This combination has been shown to increase the positive influence of chemical odors on people's attention and choices both in laboratory experiments (Krishna, 2012; Covington et al., 2018; Gaby & Tepper, 2020) and in field studies that included scents in retail stores, offices, and restaurants (Krishna, 2012; Spence, 2015; Errajaa et al., 2020).

Thus, if we look at the possible influence of congruence in the virtual context, we can propose the following hypothesis:

(H2a) The congruence between the digital scent and the product enhances the influence on consumer intention.
(H2b) Congruence between the digital scent and the product enhances the influence on the consumer's choice.

To prove these hypotheses, we proposed the following conceptual model, which we tested in two studies. In the first experiment, we set out to check the possible influence of digital scent in a context of neutrality, where there would be no congruence between the scent track and the product (Figure 1). In the second study, we would test the influence of the congruence between the technology and the product.

Figure 1: Research model



Source: The authors (2024)

3 STUDY 1

The goal was to analyze, in a neutral context, whether the selected digital scent is capable of positively influencing consumer intentions (H1a) and whether it influences consumer choice (H1b) online.

3.1 Design and procedures

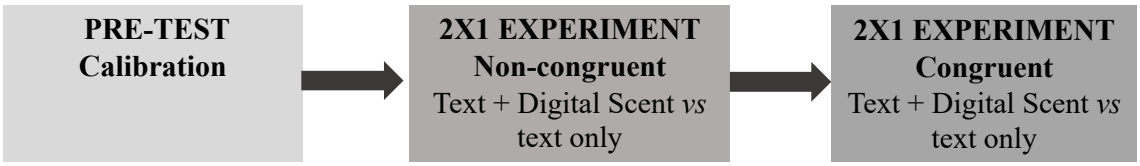
A single factor study was conducted with two conditions: exposed vs. non-exposed to the technology, taking into account the context of neutrality (no congruence between the elements). These studies required prior approval from the Ethics Committee (No. 5.127.450) due to the fact that they involved human sensations.

The conditions of the laboratory and the preparation of the mechanics of the experiments were carefully designed to minimize the influence of ambient odors (Spence, 2021b). For this research, two laboratories were isolated within a university, located in a sector that had little influence from outside smells and could be used exclusively for the tests. These rooms were set back from normal areas and the windows could be sealed. Both the application labs

and the researchers needed to be as odor-free as possible, so the products used to clean the rooms and for personal hygiene were also fragrance-free, and no perfume of any kind could be used on application days.

The preparation protocol for the survey days required that the rooms be cleaned with 70º alcohol 40 minutes before use and ventilated during this time. Tables and computers were also disinfected between participants according to the COVID-19 safety recommendations, resulting in an interval of 10 to 15 minutes between participants. The experimental procedure, which was validated by the ethics committee, consisted of the following steps (Figure 2):

Figure 2: Experiment Sequence



Source: The authors (2024)

The sample selection criteria were the same for both experiments. Participants were selected randomly and according to their availability to visit the laboratories on a university campus in Curitiba. Samples were collected between September 1, 2022 and December 14, 2023. Probably for this reason, there was a concentration of student participants in both samples. Although the volunteers were selected randomly, the aim was to achieve at least a balance in terms of age and gender, since these have been mentioned in the literature as likely to alter olfactory perception.

Two links have been generated: one to gain a better understanding of the physiological characteristics and control elements listed as capable of intervening in the olfactory capacity and identification of aromas by chemical dispersion (by capture via the nostrils), such as respiratory diseases, brain trauma, antidepressants, pregnancy and exposure to the COVID-19 virus in less than two months (Majid, 2020; Niendethal et al., 2021; Ornati & Kalbaska, 2021; Bochicchio et al., 2023). The second would be to collect descriptive information from individuals to identify their olfactory ability, their perception of the aroma in the

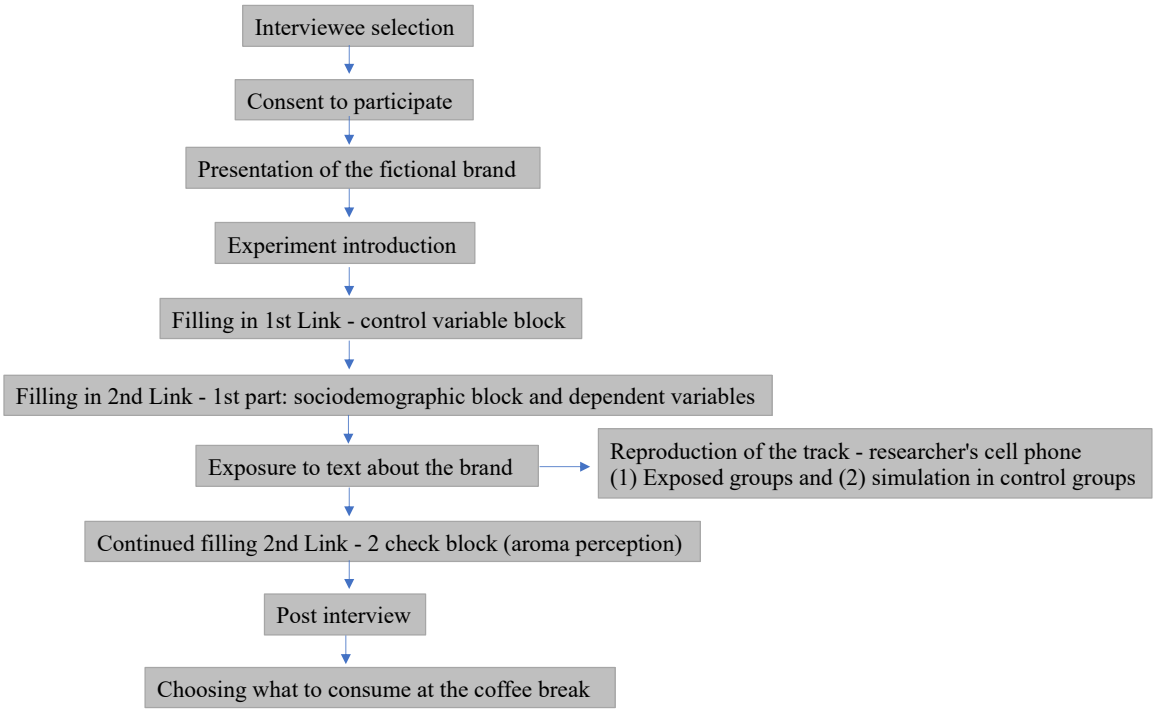
environment, about the content presented and, in a blind way, about the olfactory technology. Since the respondents would not be aware of the digital scent.

Although we have not identified scales to capture this biological or environmental interference in olfactory perception in other previous studies, these aspects were added as possible filters in the digital olfactory perception. The instrument was submitted for evaluation by marketing and knowledge management academics, along with the mechanics of data collection. The addition of the filter on the participant's relationship with the aroma of coffee, which was the common scent track in both experiments, was recommended. The aroma was chosen because, according to Gaby & Tepper (2020), it is one of the three aromas used to calibrate olfactory perceptual capacity when analyzing the chemical sense, i.e., by capturing nanoparticles that are coffee, banana, and fish, it would be possible to indicate whether the person can identify smells. The text on the brands in both studies was accessed on the computer in the research labs.

The initial proposal was to exclude participants who checked in the first link any of the items listed as possible influencers of physiological olfactory perception (controls), such as pregnancy, head trauma, use of blocking medications, smoking, or COVID-19. However, since this is a brain-based technology, it was decided to check for possible interferences when processing the data.

Since there was a step to measure consumer choice, beverage options were offered after participation in the experiment. The purpose was to verify the action in practice, as was done in Gorn's (1982) music. Participants were offered a choice of coffee, latte, orange juice, water, milk, and chocolate milk. Everything was prepared in advance to avoid aroma dispersion (especially the coffee). The coffee break room was 20 meters away from the application area and there was no interaction between the rooms. The collection process was the same in both phases (Figure 3):

Figure 3: Stages of the experiments



Source: The authors (2024)

As a description of the procedure, volunteers were given a brief presentation in the laboratory of the consent form and the proposal to participate in the feasibility assessment of these brands. The procedure was as shown in Figure 3. The proposal in the first lab experiment was to test the influence of the digital scent, so we started with a neutral context where the product was not congruent with the coffee scent track. So we developed a Swedish slow fashion brand called Känner especially for the experiment. Since we needed a storyline, the difference of Känner is that it is a conscious fashion brand, from the extraction/production of the raw material to its distribution on the market, and that it is in the process of internationalization.

In this experiment, the text was about 31 lines long, with a reading time of 1 to 3 minutes, using expressions that had a stronger association with the tactile sensation (example: "almost like feeling a breeze on your skin"). The technology was reproduced on the researchers' mobile phones to avoid any bias in the perception of the aroma between the exposed and control groups, since the mechanism claimed to be timing.

Exposure time to the track was recorded according to the number of times it had to be played (cycles). At the end of the reading, the participant was invited to continue the survey with items on olfactory perception, product perception, reading experience, and purchase intention. In the final step of the experiment, the participant was invited to drink something in a separate room. Coffee, chocolate milk, coffee and milk, orange juice, milk and water were available. Finally, they were given a chocolate. At this point, the choice behavior was verified on the spot. The aim of this protocol was to see if the technology influenced this consumption choice. The data was then processed using analysis of variance and distribution.

3.2 Pre-test

The pre-test had 19 valid responses and focused on calibrating the mechanics, technology and instrument. It was also used to identify possible adjustments or improvements that might be needed. Two professors, one from marketing and the other from knowledge management, were invited to review these items and contribute to the instrument. For the first experiment, some items were added according to this recommendation.

The first step was to conduct a descriptive analysis of the sample. Of these respondents, 10 were exposed to the technology and 9 were in the control group. The sample was selected on the basis of convenience. The socio-demographic composition had a higher concentration of women (68.4%), between 18 and 25 years old (63.2%) and students (65%).

We moved on to the manipulation test. It was necessary to check whether the digital smell was perceived. So, two questions were asked: (1) did you feel an odor while reading the text, and (2) if so, could you identify it? There was significant evidence that those exposed to the technology said they could smell something (10 out of 10). In the nonexposed group, 8 out of 9 said they couldn't smell anything. The chi-square test (χ^2 =15.354, $p<0.001$), gave a result that confirmed the manipulation of the experiment. As for the identification of the aroma, 9 out of 10 exposed people perceived and identified the odor trail as coffee (χ^2 =10.431, $p<0.05$).

The instrument included an item to understand the respondent's relationship with the scent of coffee (on a 10-point scale between not tolerating it and liking it very much) on the

recommendation of the invited scientists. This question would act as a filter to check whether the action was motivated by preference or by the effectiveness of the technology.

3.3 Results

The sample had 67 valid responses, of which 40 participants were exposed to the odorant track and 27 were the control group (not exposed). We noted a predominance of female participants (53.7%), without affecting the homogeneity of the group (χ^2 = 3.362, p=0.339), with a 68.6% age range between 18 and 25, which did not affect the perception of the digital scent (χ^2 = 5.500, p=0.481). As mentioned earlier, possibly because it was conducted on a university campus, there was a large number of students with incomplete degrees (68%). Considering that the groups were homogeneous, we proceeded to the manipulation control of the experiment.

As for identifying the digital scent, even though there was no congruence between the scent track and the product, those who were exposed indicated that they smelled something. In other words, of the 40 exposed, 22 said they smelled something and of the 27 not exposed, 20 said they didn't smell anything (χ^2 de 5.550, p<0.05). These data validate the manipulation control of the experiment. Of those exposed, 10 out of 40 clearly identified the smell of coffee and 12 said "other things" that were close to coffee but didn't say the word (e.g. something roasted).

In order to test whether this digital scent in a neutral context would influence the consumer's intention, it was necessary to verify the effectiveness of the adaptation of the purchase intention scale (Putrevu & Lord, 1994). The Cronbach's alpha of 0.852 confirms the reliability of the scale. We can see that among the 40 exposed subjects, no significant difference was found in the analysis of the Student's t-test (t = 0.-380 e *p*= 0.705) between the exposed group (μ= 6.55, sd = 2.03) and the non-exposed group (μ= 6.75, sd = 2.21). **The results of the T-test in the neutral context (table 1) do not prove H1a.**

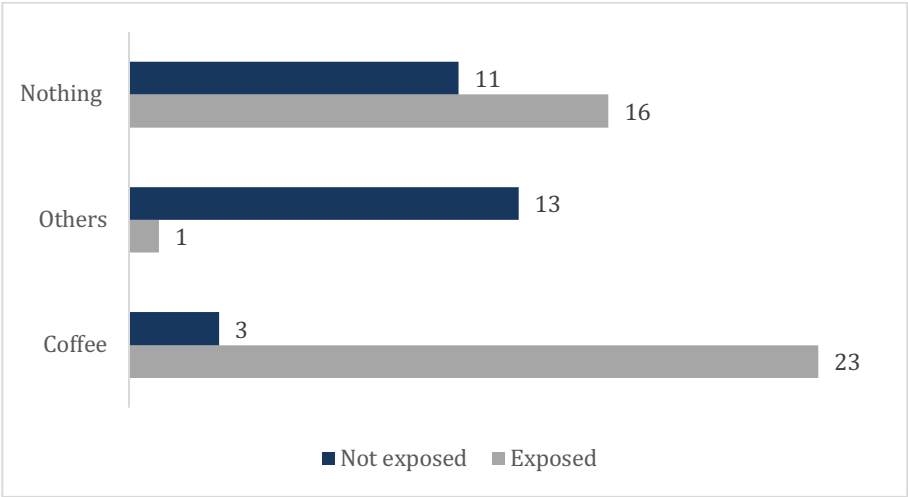
Table 1: T-test

	EXPOSED	N	Mean	Std. Deviation	T	Sig.
PURCHASE INTENTION	YES	40	6.55	2.03		
	NO	27	6.75	2.21	-.380	.575
I will definitely try this product. Where 1 would be totally disagree and 10 would be totally agree.	YES	40	7.38	2.07	-.246	.146
	NO	27	7.52	2.50		
I am very likely to buy this product. Where 1 would be totally disagree and 10 would be totally agree.	YES	40	6.73	2.29	-.806	.906
	NO	27	7.19	2.28		
I will buy this product with my next purchase. Where 1 would be totally disagree and 10 would be totally agree.	YES	40	5.55	2.57	-.009	.418
	NO	27	5.56	2.25		

Source: The authors (2024)

Observing the post-exposure choice behavior, there is an indication that the technology is inducing an action. When choosing the item to be consumed, the exposed group concentrated on the choice of coffee (58%), 40% did not want to drink anything and only 1 respondent chose from the other beverages available. In the control group, the opposite was true for the choice of coffee: only 3 of the 28 participants drank coffee, 32% chose something else and 27% didn't want to drink anything (Figure 4). These results ($\chi^2 = 25.016$, $p<0.001$) suggest that **H1b was validated because the digital scent had an influence on coffee drinking behavior.**

Figure 4: Consumer's choice



Source: The authors (2024)

3.3.1 Control Variables

The next step was to test whether the physiological control variables (filters) of olfactory perception by the chemical sense, such as gender and age, had an influence on the perception of virtual odors. Both were found to have no influence on the perception of digital odors with *(*$\chi^2 = 0.768$, p=0.381) and ($\chi x^2 = 4.020$, p=0.259) respectively. As the sample consisted mainly of university students, there were no respondents to the pregnancy/lactation filter. Regarding the use of medications that act on the central nervous system (anxiolytics, antidepressants, or beta-blockers), a total of 11 people use these medications, 5 of whom were exposed to the technology and 6 of whom were not. The use of this type of medication also had no significant effect on the perception of the olfactory track (χ^2 de 1.110, p=0.292).

Regarding the possible influence of the COVID-19 (through contamination or vaccine), 21 said they met this condition and 46 did not. Of the participants who had recently been exposed to the virus, 14 were randomly exposed to the olfactory trail and 7 remained in the control group. The virus was not found to have a significant effect ($\chi^2 = 0.617$, p= 0.432) on digital olfactory identification.

We also observed in this sample the possibility that coffee enjoyment has a parallel influence on consumer behavior. Coffee preference did not have a significant influence ($\chi^2 = 2.989$, p<0.10). It's worth noting that we had more people who liked coffee and were exposed to the scent track. Despite the fact that it was a random sample and we didn't know the respondents' preferences in advance, the results confirmed the hypotheses with a marginal result of 90% certainty.

Looking at the number of cycles respondents were exposed to, of those who said they smelled an aroma (29), 16 were exposed to 2 cycles (55%) and 21% were exposed to only 1 cycle (1m07 sec). Of the 38 who said they didn't smell anything, 21 were not exposed to the technology. We can therefore propose that an exposure time of at least 2 minutes would be required to identify the olfactory track.

3.3.2 Formative elements

In addition, the perception of the formative elements of physiological olfaction as proposed by Véga-Gómez et al. (2020) - pleasantness, familiarity, congruence, intensity and presence - was

observed, the latter being a limitation of digital olfactory application due to the lack of proximity to the olfactory source. The perception of congruence (related to H2 of this study) would have to be verified with the results of the second experiment.

To do this, we compared the responses of those exposed and those not exposed to the olfactory track, in this case in a neutral context. For intensity, we converted the values obtained between "high intensity" and "low intensity". Since we used a 10-point scale, in the first category we agreed on response values from 6 upwards, and values between 1 and 5 were classified as "low intensity". However, this element did not have a significant effect ($\chi^2 = 0.928$, $p>0.335$).

For pleasantness, we also used a 10-point scale ranging from "very pleasant" as 10 to "very unpleasant" as 0. We added the item "not applied" for those who did not feel the aroma. The results were analyzed using an analysis of variance (Student's t-test). We found no significant difference (t = 0.273 e p=0.792) between the exposed group (μ= 8.38, sd = 1.60) and the non-exposed group (μ= 8.14, sd = 2.19). However, we also found that some people who were not exposed to the technology reported smelling a pleasant aroma. Of the 40 people who had access to the digital scent, 29 said they could smell something and 26 found it pleasant. This suggests a possible cognitive influence, i.e. the text presenting the product.

In the literature, familiarity is linked to memories and associations with the individual's context. Therefore, in this study, it was proposed to test this by means of an open-ended question, so that the respondents could freely state in their own words, if they had felt an aroma, what in their context this aroma was associated with (recall or recognition). Of the 40 exposed, only 6 clearly referred to the name "coffee" when identifying the aroma and 10 did not objectively name it and were interpreted as "other". It's also important to note that we included the "not applicable" option for those who didn't notice the odor. Those who said they didn't recognize it were the most relevant, with 24 responses ($\chi^2 = 1.567$, p =0.457). It is important to note that this question focuses on olfactory associations and not their identification, as seen in the manipulation check.

3.5 Discussion

We worked in neutrality between the product and the scent track. In this case of non-congruence between the product and the digital fragrance, tactile expressions were prioritized in the text. This time, no significant effect on consumer attitude was observed.

Looking at the mean scores on the scale used, the results were close. For the exposed, the values were slightly higher (μ = 7.95) than for the unexposed (μ = 6.55). Therefore, H1a could not be supported.

When looking at the influence of digital scent on the choice to drink coffee, the offline literature would suggest that there could be a positive influence on behavior (Hertz, 2004; Zurawicki, 2010; Doucé & Janssens, 2013; Petit et al., 2021). The choice to drink coffee when only the olfactory track was evaluated had a significant effect on consumer behavior, supporting H1b.

The control elements mentioned in the offline literature as being able to influence the chemical olfactory perception, such as age, gender (Doty et al., 1974; Ellen & Bone, 1998; Croy et al., 2014; Chatterjee, 2022), pregnancy/lactation, medication acting on the central nervous system or COVID-19 (Majid, 2021; Spadera et al., 2022; Dal Bò, 2022; Chatterjee, 2022), didn't show any influence in the digital scent. Regarding the familiarity/recognition of the virtual aroma, the term "coffee" was mentioned by a few people, although there is no reference to coffee in the material presenting the brand. It should be emphasized that familiarity was measured by the question "this aroma reminds you of what?", not by olfactory memory (Neufeld & Stein, 2001; De Luca & Botelho, 2020).

In terms of pleasantness, nonexposed people reported that they found the scent pleasant, suggesting that they may have been influenced by their olfactory memories associated with the brand presentation text. Even so, the number of responses that identified a scent was lower than those that said they didn't smell anything or couldn't identify it (categorized as "nothing"), which was 24 people.

4. STUDY 2

The goal was to see if, in a congruent context (text and digital scent), the scent track could potentially influence consumer intention (H2a) and consumer choice (H2b).

4.1 Design and procedures

As in the previous study, a single-factor experiment with two conditions (exposed and non-exposed) was conducted to test the influence of congruence. The product and the text were

changed to emphasize the olfactory sense (e.g., "leaves a unique and enveloping scent in the air that welcomes you and invites you to drink a cup or more"). The product was a Finnish gourmet coffee called Khavia that could be sold in coffee shops or consumed at home, and in the storyline we added that the brand was in the process of internationalizing. Since we were using the same olfactory technology, approval for this step had been submitted to the Ethics Committee together with Study 1 (No. 5.127.450). The mechanics and the preparation procedures for the laboratories and the researchers were the same as in the first experiment and were strictly followed. The laboratories used were also the same. The period was immediately after the data collection of the previous experiment, so that H2 of the research could be studied.

A new sample was selected, also randomly, taking into consideration the possibility of going to the university where the laboratories approved by the Ethics Committee were located. Also in this collection, we tried to balance, as much as possible, the control elements already adopted in the first study (age and sex).

The coffee brand presentation text was slightly longer at 50 lines (2 to 3 minutes reading time). Since the olfactory trail was the same, the rationale for having the digital aroma available on the researcher's cell phone was maintained so that it would be possible to maintain the argument that we were timing the reading time to standardize the mechanics between those exposed and those not exposed.

4.2 Results

The first study focused on verifying the possible influence of digital scent on consumers' intentions and choices in a neutral context. In this experiment, we sought to analyze the possible congruency-enhancing effect identified in offline studies (Doucé, 2022; Brengman et al. 2022).

The study was conducted at exactly the same site, with a new independent sample of 63 qualified responses. In terms of the distribution of the sample in terms of exposure to technology, 35 had access and 28 did not (the control group). Descriptive analysis shows that 53.1% of the participants were female, 40.6% were male, and 6.3% were non-binary. Of the participants, 78.1% were in the 18-25 age range, with a predominance of students

from diverse backgrounds (85.9%). There were no differences between groups within this demographic information, resulting in a homogeneous group.

The manipulation check of this experiment significantly confirmed that the exposed reported smelling something (35 out of 35 exposed respondents). Of the 28 unexposed, 16 said they didn't smell anything (χ^2=26.809, p<0.001).

As for the purchase intention or choice, the scale of Putrevu & Lord (1994), which has already been checked for reliability, was used again. It can be seen that of the 35 exposed, the Student's t-test analysis showed no significant difference (t = 0.272 e *p*= 0.321) between the exposed group (μ= 7.95, sd = 1.84) and the non-exposed group (μ= 7.83, sd = 1.62). Again, the mean between the exposed and control groups was very close. The results of the Student's t-test (Table 2) do not prove that the congruent context increases the influence of the digital scent on purchase intention. Therefore, **H2a was not confirmed**.

Table 2: T-test

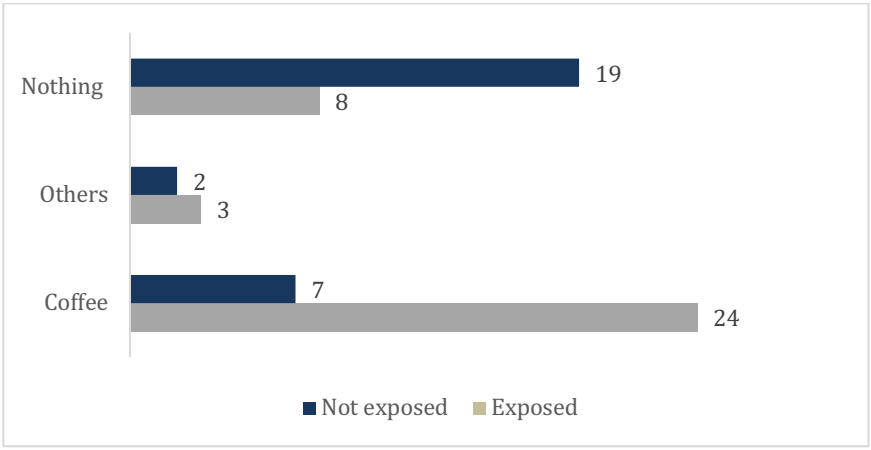
	EXPOSED	N	Mean	Std. Deviation	T	Sig.
PURCHASE INTENTION	YES	35	79.524	184.203	.272	.321
	NO	28	78.333	162.415		
I will definitely try this product. Where 1 would be totally disagree and 10 would be totally agree.	YES	35	8.71	1.601	.181	.836
	NO	28	8.64	1.521		
I am very likely to buy this product. Where 1 would be totally disagree and 10 would be totally agree.	YES	35	8.09	1.853	.335	.513
	NO	28	7.93	1.844		
I will buy this product with my next purchase. Where 1 would be totally disagree and 10 would be totally agree.	YES	35	7.06	2.612	.210	.410
	NO	28	6.93	2.243		

Source: The authors (2024)

In terms of post-exposure choice behavior, there is also evidence that the technology stimulates choice. When choosing what to drink at the coffee break, the exposed group focused on coffee (68%), 22% drank nothing, and only 3 people chose juice or chocolate milk (Figure 5). In the control group, the result was the opposite: 25% of the 28 participants

drank coffee, 2 chose something else, and 68% didn't want to consume anything ($\chi^2 = 13.392$, $p < 0.001$).

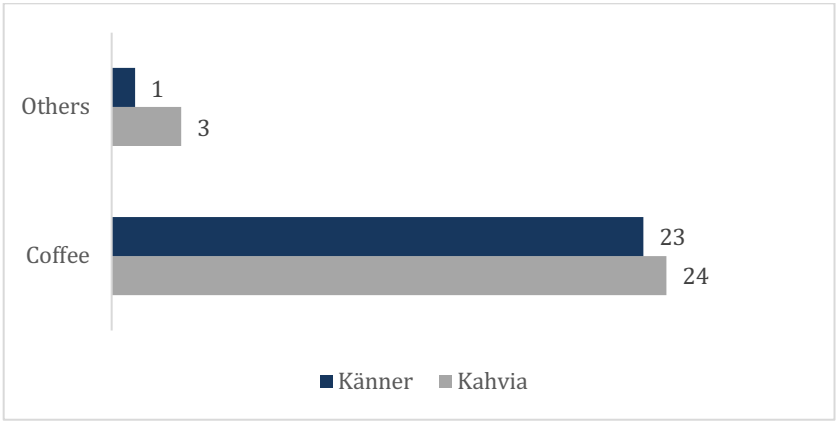
Figure 5: Consumer´s choice



Source: The authors (2024)

However, to test whether congruency would improve consumer choice, a chi-squared comparison was made between the proportions of those exposed to each context (Kahvia Vs. Känner) and the action of choosing what to drink (Figure 6). The results show that regardless of the context, the influence of the olfactory track was similar on the respondents' choice (χ^2 0.848, p=0.357). This means that **H2b cannot be supported.**

Figure 6: Comparative consumer´s choice



Source: The authors (2024)

4.2.1 Control Variables

Since the procedure was the same in both studies, differing only in context, congruence was examined in this experiment. With respect to the physiological control variables (filters),

such as gender and age, they did not prove to be influential in the case of the digital scent in the congruence scenario with (χ^2=0.272, p = 0.602 e χ^2 =1.899, p= 0.594). As the sample was a convenience sample within the same university campus, it was also not possible to check the pregnancy/lactation filter, as only 1 participant with this profile was obtained. Regarding the use of medications that act on the central nervous system, only 9 participants in total used these medications, 5 of whom were exposed to the technology and 4 of whom were not. Looking at the results, this control also showed no significant influence on the perception of the olfactory track (χ^2 de 0.815, p = 0.665).

Among the participants who had access to the technology regarding exposure to COVID-19 (or vaccination), 37 participants were not exposed to the virus in less than two months and 25 were. Of those exposed to the virus, 14 were also exposed to the technology. As in the pre-test and the first experiment, exposure to the virus did not have a significant effect on digital odor perception (χ^2=0.836, p= 0.658).

In addition to the control variables, we also tested the possible interference of "coffee enjoyment", so that we could check whether, in the context of congruence, a taste for the beverage could interfere with the consumer's choice, parallel to the technology. The results indicate that there is no significant influence of the participants' relationship with coffee (χ^2 de 0.064, p =0.511).

4.2.2 Formative elements

We analyzed how the formative elements of aroma would be perceived in the case of this online technology. We compared the responses of those of the exposed group with those of the control group, this time in a congruent context in which the product and the scent track were associated. In the case of intensity (high and low), we found no significant influence (χ^2 = 0.327, p = 0.567). For pleasantness, the results were again treated by an analysis of variance (Student's t-test) which compared the exposed group (μ = 9.46, sd = 0.78) and the control group (μ= 7.24, sd = 2.75), finding a significant difference between them (t = 4.498, p< 0.001), and it can be proposed that this element is perceived and has an influence on the perception of digital aroma in the coherent context. When we analyzed the familiarity of those exposed (of which there were 35), 18 perceived the smell of coffee.

The number of cycles that respondents were exposed to is a way of checking whether the length of time they were on the track had any effect on their ability to pick up the technology. In the case of Khavia, we found that 66% of those who said they smelled something and could identify it were exposed to between 2 and 3 cycles. Of those, 34% had 2 cycles and 32% had 3 cycles. This leads us to believe that it would take at least 2 cycles or 3 minutes of exposure to the scent for it to be correctly perceived.

4.4 Discussion

In this study, there was congruence between the aroma and the product. In this scenario, in general terms, the olfactory track did not show a significant influence on consumer attitudes according to the Petruvu and Lord (1994) scale, but on the other hand, it was shown to be capable of influencing choice behavior in the stage adapted from Gorn's research (1984). What could not be verified was that, as in the offline studies, the congruence between the technology and the product did not have the potential to influence behavior in the action of choosing what to consume. In other words, **H2a and H2b could not be confirmed.**

Regarding the elements identified in previous offline studies as being able to influence physiological olfactory perception, which we consider as controls or filters (Doty et al. 1974; Ellen & Bone, 1998; Croy et al, 2014; Chatterjee, 2022), we considered those most frequently mentioned in the literature and already used in Experiment 1: (age, sex, pregnancy or lactation, use of beta-blockers/medications acting on the central nervous system) and exposure to the COVID-19 virus (Dal Bò et al., 2022; Ornati & Kalbaska, 2022). As in the first experiment of this research, they did not show any influence on the perception of the digital scent in the congruent context. When we compared perception between the exposed and control groups in terms of who perceived the odor, there was no difference.

Among the formative elements of the aroma proposed by Véga-Gómez et al. (2020), the one that had the greatest influence on the congruent context was familiarity/remembrance. In an open-ended question, 18 of the 35 participants who had contact with the olfactory track unambiguously identified the smell of coffee. Intensity, as in the first study, did not prove to have a significant influence. This invites us to investigate whether the fact that the technology passes directly through the nervous system and not through the olfactory neuroepithelium could "confuse" the respondent as to whether they felt or remembered the

aroma. This could be related to possible differences between olfactory sensation (physiological) and olfactory perception (cognitive) Khrisna et al. (2017).

Pleasantness was perceived by the exposed group with much higher mean scores than the control group. However, we can see that some respondents who did not have access to the digital olfactory track indicated that they also found the aroma pleasant. With this in mind, we believe it would be pertinent to apply the analysis of the control and design elements of the odor in relation to who may have triggered the perception of the aroma, in other words, to analyze the influence of these elements in relation to who indicated that they "smelled" the scent, regardless of exposure to the technology.

When the elements were analyzed in comparison to "who felt", intensity had a significant influence ($\chi^2 = 8.801$, $p<0.05$). In the case of analyzing pleasantness by comparing exposure to technology with feeling, the analysis of variance showed a large difference with the means obtained compared to the association with exposure to technology. The results show a significant difference (t=10.455, p< 0.001), with higher means for those who felt (= 9.36, sd = 0.76) than those who didn't (m = 4.78, sd = 2.54). In terms of familiarity, the intersection between "who felt it" and the associated aroma was also not significant ($\chi^2 = 3.591$, p =0.166).

5. IMPLICATIONS AND RESEARCH AGENDA

5.1 Theoretical contributions

One of the points that we wanted to explore in this study is the feasibility of adopting virtual access to smell. Previous research, such as that by Spence et al. (2017) and Petit et al. (2019), has already shown a tendency to look for solutions to enable the perception of smell, texture, and taste virtually to make the online experience more immersive, but there is still a need for more practical studies.

A large part of this interest by academics is because the sense of smell has been identified in the literature as the sense with the greatest potential to generate emotional and affective connections (Herz, 2004; Altamore et al., 2018; Abdolmohamad et al. 2022) and capable of generating an action, an instinctive response (Gottfried, 2006; Olofsson, 2014; Olofsson et al., 2017). In other words, in the empirical studies conducted offline, analyzing the biological

response to odors (Spence, 2011), the influence on the perception of taste (Spence, 2011; Spence, 2015; Sandell, 2019a; Petit et al., 2021), quality (Spence, 2015; Biswas & Szocs, 2019; Berčík et al, 2021; Doucé, 2022), memory access (Engen & Ross, 1973), influence on consumer behavior (Bone & Ellen, 1999; Morrin & Ratneshwar, 2000; Krishna et al., 2017; De Luca & Botelho, 2020), perception of the environment (Stenslund, 2015; Henshaw et al., 2016; Spence, 2020a), and also on purchase intention (Doucé et al., 2016; Véga-Gómez et al., 2020), have highlighted the potential of olfactory marketing.

In addition to these findings on the influence of aroma on consumer behavior in these previous studies, we were able to see that there is a recommendation to develop studies that consider the adoption of online olfactory marketing, especially from a practical perspective. Systematic reviews such as Panagiotakopoulos et al. 2022; Brengman et al. 2022; and Chatterjee, 2022, as well as theoretical articles exploring the possibility of enabling olfaction virtually and in the metaverse (Suominen et al. 2018; Petit et al. 2021; Panagiotakopoulos et al. 2022; Doucé, 2022). This means that, although these are recent studies, there is still an opportunity to conduct empirical studies on how to structure the adoption of virtual aroma opportunities and their possible effects.

In a practical sense, we wanted to answer the question: In virtual reality, would an aroma promote an action, even in a context where the product and technology are not aligned?

To answer this question, we proposed - among the possibilities of emerging technologies in the field of Human-Computer Integration (HCI) or cybernetics - to test the viability of a technology that aims to convert inaudible sound waves into MP3 scent tracks.

Since this is the first study to test this technology, we decided to test its effectiveness by combining the digital scent with the presentation texts of two products developed for this research. A neutral product (fashion) and a congruent product in another experiment, which would be a coffee brand. The aim of this combination was to take the first step in understanding the possible influence of technology on people's attitudes and actions.

Therefore, in order to test the influence of digital on both intention and choice, reinforcing that they are different moments in the consumer's decision, we adapted the Petruvu & Lord (1994) scale to measure intention and the mechanics of the Gorn (1984) study to measure the choice to consume during the coffee break. As in the experiments on different segments

of the sense of smell in "real life", it was suggested that the congruence of the aroma with the product potentiates the attitude and behavior of the exposed respondents, so we conducted two experiments. The first, considering a neutral context, in other words, wouldn't have a congruence between the coffee olfactory track and the sustainable fashion product. As for the second, the elements would be congruent, using the same digital coffee scent, this time associated with a gourmet coffee brand.

At the same time, we wanted to take a further step in understanding the possibilities of consumer responses to olfactory marketing in the online environment. We wanted to verify if the elements that control the perception of an odor through the chemical sense would have an influence in the case of a digital odor. Namely, would age, gender, pregnancy, medication or COVID-19 influence the olfactory perception of the exposed person? (Doty et al. 1974; Ellen & Bone, 1998Spadera et al., 2022; Dal Bò et al., 2022; Ornathi & Kalbaska, 2022, Doucé et al., 2022). These aspects don't seem to have influenced the perception of the aroma in both experiments, compared to the results obtained between exposed and non-exposed subjects.

In addition, we decided to verify the possibility of an influence of the elements that would be fundamental for an aroma in the chemical sense, presented by Véga-Gómez et al. (2020) as: presence, congruence, intensity, pleasantness and familiarity, related to memories and/or associations that an odor may have. To determine whether these design elements interfered with olfactory perception, we compared the results between the control groups and those who had access to the technology in both experiments. However, we did not find any major differences.

The hypothesis that digital scent influences attitudes was not supported in any of the cases; however, the technology did demonstrate the potential to influence consumer behavior in both neutral and congruent contexts. In terms of behavior, although it was expected that the influence on behavior would be greater in congruent contexts, we obtained a significant response in consumer action regardless of context.

5.2 | Managerial implications

The contribution that we believe this study can make to marketing managers is to suggest ways in which olfactory marketing can be adapted to the online reality. Our proposal was to

test a digital scent solution that could be associated with different contexts in which chemical olfaction is not accessible. Our research conducted initial tests of a technology that aims to convert inaudible MP3 sound waves into an olfactory track, in this case coffee, with the combination of presentation texts for two products developed for this research, a Swedish sustainable fashion brand (neutral context) and a Finnish gourmet coffee brand (congruent context).

In the technological choice of this study, in the context of a coffee olfactory track, the results indicated that there was an influence on the behavior of respondents who prioritized the choice to consume coffee. This influence occurred both when the aroma was not directly associated with the product and when there was no congruence, which may indicate the acceptance of the technology.

At the same time, this first study of a digital fragrance solution gives managers insight into the possibilities of using new technologies in online fragrance marketing. It allows managers to virtually analyze the availability of scents and can help to identify the possible interference of the control elements in the olfactory perception, if the formative elements of the scent would be the same in the virtual scenario.

We have identified some limitations, opportunities for further study, evolution and developments in this study, which we present below.

5.3 | Limitations and future research

We found some limitations in conducting this research that are important to review later. As this was an unpaid study, respondents were selected based on their availability and interest in participating. For this reason, the profile of the respondents was very concentrated in a certain age group and socio-cultural context. This may lead to some bias in responses and similar perceptions.

A second limitation was the question of the person's relationship to coffee. By chance, there was a concentration of respondents who said they liked the drink who had been exposed to the technology. Since the data was not checked until after it was collected, and access to the technology was randomized, there was no control for this. This could possibly be included as a preliminary filter in future studies. Issues of social or cultural context and associations made

between aromas as pleasant or unpleasant could be parameters that could alter the decoding of the digital aroma, as happens with offline smells. As the sample, although random, was concentrated in one group, it is interesting to verify the possibility of influence and perception with a diverse group, preferably cross-cultural.

A third limitation was the design of some of the questions. We asked an open-ended question after the item that asked whether "you smelled any aroma while reading the text". The aim of this question was to allow the respondent to answer freely, without bias or interference, about the aroma "that would have been picked up". However, the results would have to be interpreted and synthesized into a word by the researchers in order to be processed (such as: "coffee", "other", and "nothing"). In this categorization, the missing was also treated as "nothing". Since this is an interpretation of the data, there may be differences in the meanings assigned depending on the context of the respondents. In this study, we tried to be conservative and only assign the meaning associated with the title when the word "coffee" was mentioned.

Since we used an olfactory cue for coffee in these experiments, there is evidence that the influence on coffee-choice behavior was significant, even when the exposed respondents said they did not smell it. In both the neutral and congruent contexts. This may have been influenced by the fact that many respondents indicated that they "like coffee" or by the perception of the technology. Therefore, we believe that collecting data with an aroma that is not associated with food may help to understand the high number of people who have consumed coffee, even with a clothing product. With an aroma that is not associated with a food item, especially one with significant acceptance like the one in this track, it could help to see if a non-food track could inhibit the choice to drink coffee, for example.

Something that could also be investigated in future studies is the comparison between the perception of technology and cognitive triggers. It would be necessary to develop a comparative study between the two elements and test whether there would be a dominance relationship between scent technology and cognitive triggers in non-congruent contexts (Lwin et al., 2016; Jang & Lee, 2019; Doucé & Adams, 2020) and whether either of them would be effective in promoting action in the online reality.

Since we have used a text in this research, it is also important to know the comparative

relationship with stimuli via images and sounds with the olfactory track. It's interesting to see if resources that access other senses, such as the visual sense with sensorially treated images (lighting, effects), augmented reality, virtual reality, and videos, would have the same type of dominance and/or influence on behavior in non-congruent cases.

Subsequently, to verify the possibility of online adoption, we recommend investigating whether the relationships and possible influences on the individual would be the same with the browsing experience (touch). In other words, it is necessary to explore whether interaction (exposure to browsing websites or social media) and culture (social reality) would have an influence on the perception of technology and its performance.

As for the type of olfactory technology tested, since the proposal we used is to act directly on the nervous system, transforming a mechanical sense (hearing) into an odor, it is necessary to understand whether, if there were a fictitious "odor source", people would identify the odor. In other words, would the act of identifying the possible presence of an olfactory source, even if it is not congruent, change the perception/identification of the odor? This suggestion is based on the fact that, during the collection, many of the respondents made the instinctive gesture of searching for the source of the odor and dilating their nostrils. In other words, as if they were looking for an odor that the brain could have identified.

Since this is something that is intended to act unconsciously, directly on the limbic system, and can "demand" a re-education or adaptation in the way we "feel the scent", it would be important to analyze the ethical issues surrounding its use. Since in some cases the possibilities are totally virtual, for example in the case of this study it was inaudible, it is necessary to understand what the limits and rules are for adopting it online. It is necessary to examine the possibilities of regulation and to measure the effects on a large scale.

With regard to the formative elements and technology, it may be necessary to investigate how these elements would be captured in the digital scent, since they act through the nervous system and not the chemical olfactory system, or if there are other elements that should be considered in its formation. For example, we didn't find a significant influence on intensity in those exposed to the olfactory track, did this element affect its perception or is its interference irrelevant since it is a neural action?

We also recommend developing studies in which the design compares the bases collected. Since this was a first round of experiments, we opted for a model with greater control (2x1) to try to reduce possible interference in the respondents' perception of the digital scent. In future studies, it would be interesting to adopt a 2x2 model and compare the bases to see if there really is an influence of the olfactory track according to the context.

In addition, it may be appropriate to promote a comparative study between this Scent by Sound technological solution and other proposals. First of all, we can recommend a comparison with the proposal of Niedenthal et al. (2021), which is a radiofrequency device for the re-education of the sense of smell after the loss of the sense, with the possibility of being 3D printed.

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ARTICLE 3

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BEYOND DIGITAL SCENT: VERIFYING ITS INFLUENCE ON FOOD CONSUMPTION AND THE PERCEPTION OF INDIVIDUALS

ABSTRACT

The primary objective of this study was to investigate whether a virtual non-food aroma could influence beverage and food consumption behavior, even when participants indicated a pre-existing preference for items such as coffee and chocolate. At the same time, we aimed to analyze whether the presence of a digital scent with floral and talcum powder notes could alter individuals' concentration and perception of time, both when the product and the virtual scent were present and when they were not. In addition, as a control, we wanted to examine whether biological aspects identified in the literature as being capable of interfering with olfactory perception in a chemical sense would have any effect on the perception of the olfactory technology. To explore these possibilities, we conducted a series of experiments, including a pretest and two 2x1 laboratory studies, using a technological solution that converts sound waves into olfactory tracks in MP3 format, known as Scent by Sound. In addition, we felt the need to analyze whether the responses obtained with the virtual scent would be similar to those obtained with the chemical scent. For this purpose, we conducted a 2x1 field experiment with food items. The paper concludes with theoretical and managerial contributions and presents possibilities for future studies.

Keywords: Digital Aroma; Online Olfactory Marketing; Sensory Congruence; Consumer Behavior.

1. INTRODUCTION

How much can sensations influence our behavior? Can the senses influence our perception of reality? According to authors such as Engen & Ross (1973) and Krishna (2012), human sensory experiences are fundamental in shaping our perception of the world around us, from determining whether things and situations are pleasant to assessing whether they are safe or risky. Although extremely important and generally innate to humans, this chain of sensations and the interaction of the senses can be complex to understand and even replicate. To better understand how this process occurs and how to use it strategically, sensory marketing has become a trend in empirical studies in offline reality and an additional tool for marketing managers to attract more consumers, improve brand positioning and enrich the shopping experience (Krishna, 2012; Véga-Gómez et al., 2020).

As humans are multisensory and access more than one sense simultaneously, it was observed that when one of these sensations is smell, the response is more intense and faster (Lawless & Engen, 1977; Roxana & Ioan, 2013; Krishna et al., 2017; Doucé & Adams, 2020; Bochicchio et al., 2023). Researchers have noted that this is due to the importance of this sense in human psychophysiology. Although smell is the third most accessed sense after sight and hearing, an aroma can develop stronger bonds, evoke emotions and affection, and more easily access emotional memories, both through association and by moving from short-term or episodic memory to long-term or semantic memory (Neufeld & Stein, 2001; Hertz, 2004; Henshaw et al., 2016; De Luca & Botelho, 2020).

These capabilities have led scent to be increasingly studied in olfactory marketing from an academic perspective, and from a practical marketing perspective, it has been considered in creating an appealing atmosphere at the point of sale and even as an element of brand identity with signature scents (Bradford & Desrochers, 2009; Henshaw et al., 2016). Therefore, "understanding how and when specific scents enhance the customer experience will be key to commercial success in the coming years" (Spence et al., p. 478, 2014).

Offline olfactory marketing studies have examined the influence of aroma on taste perception (Spence & Yousef, 2015; Spence, 2015; Jang & Lee, 2019; Petit et al., 2022), on consumers' quality perception of brands (Altamore et al., 2018, Darabi & Mirabi, 2018), on increasing purchase intention or dwell time in a location (Krishna, 2012; Véga-Gómez et al., 2020), influencing how an environment is perceived (Lai, 2018; Spence, 2020b; De Luca &

Botelho, 2021; Spence, 2021a), on concentration (Olofsson et al., 2017; Spence, 2021a), and on time perception (Leclerc et al., 1995; Spangenberg et al., 1996; Herz, 2004).

Spence (2017) and Petit et al. (2019) present that technology plays a crucial role in this transposition or adaptation of the involvement of human senses in the online experience. According to these authors, until recently, "olfaction" was obtained digitally by combining images and sounds that would trigger an individual's memory, i.e., seeing or hearing would trigger the recollection or association of the image or sound with an odor. But what if it were possible to actually smell the scent of a hair conditioner, fabric softener, or even food online? Could a virtual scent influence consumer behavior, choices and perceptions? In the case of a non-food scent, would it influence the choice of food and/or beverage to be consumed? For example, would it reduce or increase consumption? It is also worth considering whether, similar to what was found offline, congruence would have any effect on the perception of a digital aroma. The questions arising from these studies led us to investigate whether other fields of knowledge, such as medicine and Human-Computer Interaction (HCI), had proposals that would allow virtual olfactory perception.

We have observed that recent studies have presented technological solutions that were originally developed with the expectation of providing or re-educating the sense of smell virtually for those who have lost the ability to smell for health reasons. Some of these proposals allowed "smelling" even at a physical distance from the source of the aroma (Niedenthal et al., 2021). In other words, they aimed to allow the olfactory system to function even without ingesting chemical nanoparticles, which would have an interesting appeal to adapt these medical possibilities to marketing. To consider this hypothesis, it is important to test the feasibility of at least one of these solutions, preferably with potential for online adoption. Thus, we chose an alternative that proposes to convert sound waves into aromas through inaudible MP3 tracks. This gave us the opportunity to test whether, in addition to potentially influencing behavior, a digital scent would interfere with time perception and concentration. In addition, we needed to understand if, in the case of a virtual perfume, the congruence between the digital aroma and the product would have an enhancing effect on the above relationships.

Since we decided to use a calming non-food scent with talc-like and floral notes, in the first round of the experiment, which would be noncongruent, it was associated with a gourmet

coffee brand. In the second round, which would be congruent, the aroma was paired with the text of a slow fashion brand. In each data collection, we divided the respondents into a group that was exposed to the technology and the text, and another that had access only to the text. The behavioral stage would be verified by the consumption choice of beverages available during a coffee break. For time perception, we adopted the comparison between self-perception and chronometer time, and the level of concentration would also be from the participant's perspective (Spangenberg et al., 1996).

Since this is an aroma with calming and relaxing notes, we think it would be important to conduct a field experiment with the diffusion of an aroma considered to have the same characteristics as the olfactory track. In this way, we could compare the possible influence of the chemical fragrance versus the virtual one on people's food choice behavior.

Thus, our research included a brief literature review, two 2x1 laboratory experiments testing the digital aroma in a single collection, and also a 2x1 field experiment with the non-food aroma accessing the chemical sense of smell, comparing two independent samples.

2- BACKGROUND

2.1 Olfactory sensory marketing

As consumer expectations have evolved, marketing has come to consider the experience of interacting with a brand as important as the product itself, and has therefore searched for solutions that encourage people to act (Kotler & Keller, 2018). One such strategy used by managers is the use of scent. Because people are 100 times more likely to remember an odor than something they see, hear, or touch, scent holds significant potential for marketing strategies (Herz, 2004; Bradford & Desrochers, 2009). Previous offline studies have shown that retailers have begun to invest in incorporating scents at the point of sale. In other words, to create an atmosphere that captures people's interest and encourages a response ranging from buying something to spending more time in the space, olfaction has become a key sense (Kotler, 1973; Solomon, 2016; Kotler & Keller, 2018). This sensory engagement has been found to increase retail purchase intentions (Lawless & Engen, 1977; Lindstrom, 2012; Peruzzo, 2015) and influence consumer behavior (Doucé et al., 2016; Véga-Gómez et al., 2020).

It has also been observed that a scent can evoke memories with emotional associations and exert a greater influence on behavior because smell most effectively accesses the limbic system, generating instinctive and immediate responses (Engen & Ross, 1973; Herz, 2004; Vlahos, 2007). For these researchers, this reinforces the idea that our other senses allow us to think before we react, even if only for fractions of a second. With smell, however, when we detect an odor, we react first and think later. Another relevant aspect of smell is that it cannot be turned off; we cannot choose to access it because we need to breathe. Therefore, we are always detecting odors, some consciously and some unconsciously (Engen & Ross, 1973; Vlahos, 2007; Bradford & Desrochers, 2009). Given these possibilities, scents have been adopted as a marketing strategy tool to attract consumers' attention to products and services (Bradford & Desrochers, 2009; Panagiotakopoulos, 2022; Chatterjee, 2022; Abdolmohamad et al., 2022; Brengman et al., 2022; Bhardwaj et al.,2023).

However, understanding how to intentionally include a fragrance requires knowledge of the possible associations and responses that the scent has for individuals, recognizing that context influences its effectiveness and presentation. Véga-Gómez et al. (2020) emphasize that studying the influences of aroma remains a challenge for research in this field. We observed that offline experiments—whether in laboratories or field studies—had the limitation of difficulty in verifying the response to a scent due to its sensitivity to various individual and environmental variables. For example, as identified in some research, the chemical sense of smell has biological aspects that interfere with its perception, such as age and gender (Doty et al., 1974; Ellen & Bone, 1999; Chatterjee, 2022), the use of medications that affect the central nervous system like beta-blockers, antidepressants, and anxiolytics, having suffered a cranial trauma, pregnancy or breastfeeding (Gaby & Tepper, 2020), and also pathological issues such as respiratory diseases, cancer, degenerative diseases, and COVID-19 (Majid, 2020; Ornati & Kalbaska, 2021; Spadera et al., 2022; Bochicchio et al., 2023). We consider these biological aspects as control elements in this study.

Beyond these filters, it has been found that environmental and cultural differences can also influence the perception and association of an aroma through the learning process in any context (Ferdenzi et al., 2016; Koubaa et al., 2020; Xiao et al., 2020). This occurs because humans begin to identify and associate aromas during gestation. The olfactory system is the first sense to develop and is formed by 12 weeks of gestation (Herz, 2009). Thus, the mother's associations with an odor may predispose the fetus to perceive it as pleasant or

unpleasant as a defense mechanism, but this process can be later influenced by associative learning of odors (Herz, 2009; Bradford & Desrochers, 2009).

2.1.1 Influence of Aroma on Behavior

Fragrance acts as a priming agent capable of triggering responses in individuals (De Luca & Botelho, 2020). Empirical studies on the use of aroma have shown that in some cases, people can detect and identify an odor and associate it with a product or environment, which can elicit a positive or negative response depending on the emotional association. In other situations, even without consciously perceiving the use of a scent, it is processed by the olfactory system and can still elicit a specific response, albeit involuntarily (Bradford & Desrochers, 2009; Henshaw et al., 2016; Urdea et al., 2021). This finding highlights the possibility of using scent subliminally in marketing or advertising campaigns to influence consumer behavior and raises ethical considerations regarding olfactory marketing (Gaillet et al., 2013; Spence, 2015).

This means that due to the physiological interaction characteristics of olfactory priming, for exemple, stimulating or relaxing, it can generate instinctive results through its access to the limbic system and its associative action with emotional and affective memories. When there is strategic intentionality in adopting a fragrance, the results can be enhanced in this regard. According to Bone & Ellen (1999), the impact of aroma can be observed in three areas: (1) affectivity and evaluation responses; (2) purchase intentions and repeat visits; and (3) time spent in the decision-making process. This invites olfactory marketing to explore other possibilities of aroma influence that go beyond aspects such as taste perception, quality, increased purchasing, and extended time spent in an offline environment.

To examine these possible influences of an odor, especially in an environment, we should consider three possibilities or steps: (1) the presence or absence of the odor; (2) the pleasure the odor can provide; and (3) the congruence between the odor and the context (Bone & Ellen, 1999). In addition, they highlight the relationship between scent and consumer memory, which can be used strategically to influence consumer perceptions and behavior, both in physical environments and potentially on online platforms.

An odor has also shown the ability to affect an individual's concentration. Olofsson et al. (2017) found that the introduction of certain scents could change an individual's

concentration during certain moments in video games. Spence (2021a & 2021c) argues that in certain situations, such as public transportation, a scent can reduce anxiety by decreasing concentration, while in other cases, the presence of a more stimulating specific scent could increase concentration and attention, such as when driving a car. Examples of off-line scents that have been shown to have a stimulating effect include coffee, rosemary, and citrus, while others, such as wood, flowers, or talcum, have had a relaxing effect, causing people to stay longer in a place (Eghil et al., 2010; Spence, 2021c).

The influence of fragrance on concentration levels is relevant as there are increasing stimuli that can divert consumers' attention, or in other situations where greater individual involvement is required, such as in service areas. Understanding how scents can influence quality perceptions and brand experience is critical, whether it is maintaining high concentration or reducing it in situations such as standing in line (Spangenberg et al., 1996).

Indirectly related to concentration is the perception of time. This aspect has been the subject of some aroma acceptance experiments. Given the behavioral changes promoted by digital reality, time, or rather the perception of time spent on each activity, has become even more relative for consumers (Spangenberg et al., 1996). For example, the acceptable amount of time for activities such as waiting for service or loading an online page should feel shorter than it actually is to achieve a satisfactory perception; otherwise, consumer frustration may develop. In other cases, such as the time spent in a theme attraction, it may be necessary to distract from the perception of time to make it feel longer (Spence, 2021c).

Fragrance has also emerged as a possibility in this context. Experimental studies have shown that people's perception of time can be altered depending on the scent used. An example presented by Eghil et al. (2010) showed that when the aroma was stimulating, such as coffee, the perceived time was shorter than the actual time clocked. When the aroma was associated with something calming, such as talcum, the perceived time was longer, even though it did not match the actual time. It was also found that when there was congruence between the aroma and what was presented, people also felt that less time had passed (Spangenberg et al., 1996).

The literature identifies several ways to measure this potential influence of aroma on time perception, such as the model proposed by Mehrabian and Russell (1974). This model

suggests several methods for assessing the influence of external elements such as aroma on individuals' perception of time, including: (1) verbal estimation, in which individuals report how long they believe they spent or took to complete a task; (2) reproduction, in which something such as a sound is presented and individuals indicate the time interval through operations; (3) production, in which respondents are given a specific time to do something that they believe they would complete within that time; and (4) comparison, in which the reported time measure is compared with the actual time clocked.

2.1.2 Online Olfactory Marketing Opportunities

Given the potential influence of scent and the need to continuously innovate strategies and provide pleasant experiences in different contexts, organizations have shown an increasing interest in adopting olfactory marketing in environments, products and overcoming the barriers of virtual contexts (Olofsson et al., 2017; Spence et al., 2017; Petit et al., 2019). Initially, the approach focused on cognitive aspects, mainly using visual and auditory cues to "remind" individuals of an odor (Petit et al., 2019; De Luca & Botelho, 2020; Panagiotakopoulos et al., 2022). At the same time, marketing has also explored and analyzed new technologies from other fields, such as human-computer interaction (HCI) and cybernetics, that have the potential to overcome the distance barrier (Olofsson et al., 2017; Covington et al., 2018; Suominen et al., 2018; McMillan, 2021; Niedenthal et al., 2021).

Due to these technical limitations, the available research is still limited when considering the potential impact of olfactory marketing in digital environments (Petit et al., 2019; Brengman et al., 2022; Chatterjee, 2022). First, it is important to understand what constitutes the formative elements of aroma. Véga-Gómez et al. (2020) suggest that aroma should have aspects such as: i. presence, ii. pleasantness, iii. intensity, and iv. congruence (which in this case refers to the mental associations consumers make between the odor and the identification of its source). In the online context, the presence criterion poses a significant challenge.

It is clear, then, that technologies that create or restore the sense of smell face much the same challenge. To better understand how these solutions might work and how they might provide an immersive online experience, it is necessary to understand both the physiological mechanisms of olfaction and its psychological mechanisms related to memory and emotion.

2.1.3 How the sense of smell works

According to Patel and Pinto (2013), the olfactory system plays a critical role in identifying substances both in close proximity and in direct contact with the body, whether through skin, taste, or smell. This process involves the detection of aromas via chemical nanoparticles that are perceived by olfactory neurons through orthonasal and retronasal pathways (Patel & Pinto; Spence, 2021a). Once captured by the olfactory neuroepithelium, signals are transmitted to the brain via axons, forming olfactory neuronal synapses that connect to the central nervous system (Gottfried, 2006; Zurawicki, 2010; Patel & Pinto, 2013). The highest concentration of olfactory neurons is located in the frontal part of the brain, where the limbic system is located. This system is responsible for linking memory, mood, associative learning, and emotion (Hertz, 2004; Patel & Pinto, 2013; Olofsson et al., 2017; Zhong et al., 2022). Neuroimaging studies show that odors, especially those that evoke autobiographical memories (AMs), activate the amygdala-hypothalamus complex and enhance emotional memory (Olofsson, 2014; Olofsson et al., 2017). Therefore, the memory of a specific odor can evoke positive or negative emotions and influence stress states, highlighting the biological link between odors, emotions, and mood.

On a conscious level, the sense of smell can be learned and trained (Niedenthal et al., 2021). The physiological mechanism of aroma requires olfactory impulses to pass through the decoding and learning area of the brain (Gottfried, 2006). This process allows for simulation by stored memory associations through other senses or by encoding how these olfactory impulses reach the nervous system in the same brain area. In marketing terms, this means that companies can use scents to help consumers identify and decode smells based on their stored memories (Herz, 2004; Gottfried, 2006; Olofsson, 2014; De Luca & Botelho, 2020; Zhong et al., 2022).

Moreover, as mentioned above, studies on olfactory stimuli indicate that memory plays a crucial role in the perception of aroma and emotional responses (Spadera et al., 2022; Dal Bò et al., 2022; Ornati & Kalbaska, 2022). Two theories of memory are particularly relevant: Bartlett's schema theory (1932) and Tulving's encoding specificity principle (1982). The former suggests that memory organizes information and experiences according to concepts and personal familiarity (Bartlett, 1932; Neufeld & Stein, 2001). The latter proposes that olfaction can evolve from episodic (short duration) to semantic (long duration) memory,

requiring naming ability for storage (Majid, 2021; Olofsson et al., 2017). These theories complement each other by suggesting that the memory of a specific odor can evoke emotions and influence consumer behavior, depending on cognitive decoding (Lawless & Engen, 1977; Bone & Ellen, 1999; Morrin & Ratneshwar, 2000; Shahid et al., 2022).

Physiologically, some factors have been identified that alter or reduce olfactory perception in a chemical sense, such as age, sex, use of beta-blockers/anxiolytics or antidepressants, pregnancy, respiratory disease, and head trauma (Gaby & Tepper, 2020). Medical studies have shown that COVID-19 infection can have side effects on the sense of smell and taste (Majid, 2020; Ornati & Kalbaska, 2021; Spadera et al., 2022). This has motivated the development of technologies to re-educate olfactory perception and gradually restore this ability. In the first few months after infection (two months), the ability to detect or identify odors is more impaired due to the intense activity of the virus in the affected body, suggesting that this should be considered as a control element in the analysis of digital odors.

Understanding these mechanisms can help us understand how some technology proposals aim to deliver aroma and how they might virtually trigger the sense of smell. These criteria could even help select a technology with potential online applicability.

2.2 Technological Possibilities for Digital Scent creation

Spence et al. (2017), Petit et al. (2019), Brengman et al. (2022), and Nakanishi et al. (2022) highlight an emerging market trend: the pursuit of digital olfactory interaction technologies that create an online shopping atmosphere capable of generating positive effects on consumers. For these technologies to be adopted in marketing, they must simulate the sensory properties of products, such as texture, aroma, and taste-senses that are traditionally only accessible in physical environments (Véga-Gómez et al., 2020; Spence et al., 2017; Niendethal et al., 2021; Panagiotakopoulos et al., 2022).

As noted by Obrist et al. (2014, p. 2844), "most work on olfaction in HCI focuses on the development and evaluation of augmented olfactory technologies." Human-computer interaction (HCI) research aims to develop technologies that enable virtual sharing and communication of olfactory experiences, especially for people with limited or reduced olfactory abilities. In the context of marketing, however, these technologies could have a variety of applications, ranging from remote events that provide immersive experiences to

supporting online purchase decisions and integrating olfactory stimuli into multimedia (Obrist et al., 2014; Murray, 2016; Olofsson et al., 2017; Panagiotakopoulos et al., 2022; Brengman et al., 2022).

HCI and cybernetics research is starting from the psychophysiological properties of olfaction to introduce virtual interaction with olfactory stimuli. This includes possibilities with aroma dispersion mechanics (Olofsson et al., 2017; Covington et al., 2018; Gaby & Tepper, 2020; Nakanishi et al., 2022) and the transmission of odors via radio frequencies in multimedia (Niedenthal et al., 2021; Spence, 2022). The global pandemic further highlighted the importance of overcoming distance barriers, especially for chemical senses such as smell, taste, and touch. COVID-19 created a scenario of social isolation/confinement that limited direct contact between people and brands. To mitigate this barrier and continue to stimulate chemical senses, visual stimuli were enhanced to evoke memories of smell and taste without providing a full sensory experience (Petit et al., 2019; Brengman et al., 2022; Panagiotakopoulos et al., 2022; Chatterjee, 2022).

We have identified several technologies that have been proposed to facilitate remote delivery of odors. A device using radio waves has been developed to re-educate olfaction after loss of olfaction due to COVID-19 (Niedenthal et al., 2021). Another innovation involves the delivery of scents via mobile devices such as smartphones and tablets, known as "digital scent tech" (Nakanishi et al., 2022). A third technology uses inaudible sound waves to decode scents and create scent tracks in MP3 format, known as "scent by sound".

The latter technology initially aimed to restore the sense of smell in patients who had lost it due to diseases such as cancer and age-related degenerative conditions. It works by adapting the neurophysiology of smell, allowing olfactory synapses to reach the brain's learning area via sound waves. Essentially, people would "feel" the scent without having to capture chemical nanoparticles, operating at a neural unconscious level. The equations that make up the olfactory tracks could be accessed on any technology that plays MP3 files. Because of its potential for online use, its non-chemical nature, and the fact that it does not require specific equipment, we chose this option to test the influence of digital scent. The developing company provided us with the olfactory tracks to conduct the studies.

2.3 | Hypothesis Development

2.3.1 Olfactory Marketing

Characteristics such as being the only sense we cannot consciously switch off, influencing around 75% of human emotions, and having the ability to stay in people's memories for a long time, make olfaction particularly interesting for marketing (Lindstrom, 2012). Add to this the fact that scents can act on the unconscious mind, triggering emotional memories and even activating the limbic system to promote instinctive and automatic responses without conscious perception, and it becomes clear why understanding how to intentionally incorporate aroma into marketing strategies is so important (Lawless & Engen, 1977; Zurawicki, 2010; Shahid et al., 2022). These aspects have been verified as aroma has shown the ability to influence individuals' choice behavior (Lindstrom, 2012; Doucé et al., 2016; Véga-Gómez et al., 2020).

Other offline effects of scent include its effects on concentration and time perception. The selection of stimulating odors has been shown to increase concentration and attention, particularly with food-related odors such as coffee and rosemary. In contrast, sweet, floral, or powdery fragrances (non-food related) increase feelings of comfort, relaxation, and calm (Spangenberg et al., 1996; Olofsson et al., 2017). This aspect of concentration is closely related to another influence of aroma: time perception. Previous studies have shown that a pleasant aroma, depending on its characteristics, can influence the perception of time spent on an activity or waiting for a service, for example (Eghil et al., 2010).

However, the challenge remains to understand whether similar responses to those found offline can be obtained if olfaction can be accessed virtually without involving the chemical senses (Covington et al., 2018; Gaby & Tepper, 2020; Panagiotakopoulos et al., 2022; Nakanishi et al., 2022). Therefore, a technology that proposes to deliver olfactory stimuli via sound waves was chosen for this study.

With the possibility of having a digital scent, the first step is to verify whether there is neural perception of the olfactory pathway. To this end, the incongruence between a non-food virtual aroma associated with a food product would allow us to identify this influence. In other words, we need to test whether the digital aroma, when incongruent, can influence consumer behavior, such as the choice of drink during a coffee break, concentration and time perception. In addition, we believe it is important to investigate whether biological control

filters (age, gender, pregnancy, central nervous system medications and COVID-19) would affect the potential influence of a calming non-food digital scent. Therefore, we propose the following hypotheses for this study:

(H1a) Non-food digital aroma reduces the choice of consuming coffee.
(H1b) Non-food digital aroma reduces consumers' perception of concentration.
(H1c) Non-food digital aroma increases consumers' perception of time.

2.3.2 Olfactory Congruence and Incongruence

One issue that has been shown to have an impact in offline studies with both food and non-food fragrances is congruence. In studies analyzing the influence of congruence between the flavor and the product or name associated with the flavor, the influence of the flavor on biological and neural responses, increased salivation, or interference with taste (Gottfried, 2006; Spence, 2011), individual attitudes (Zald & Pardo, 2000; Zurawicki, 2010; Doucé & Janssens, 2013; Chatterjee, 2022) and consumer choices (Morrin & Ratneshwar, 2000; Shahid et al., 2022; Doucé, 2022; Bhardwaj et al., 2023). For example, in studies of store environments, individuals' positive evaluations were enhanced when there was congruence between a pleasant aroma and other elements of the space (Spangenberg et al., 1996).

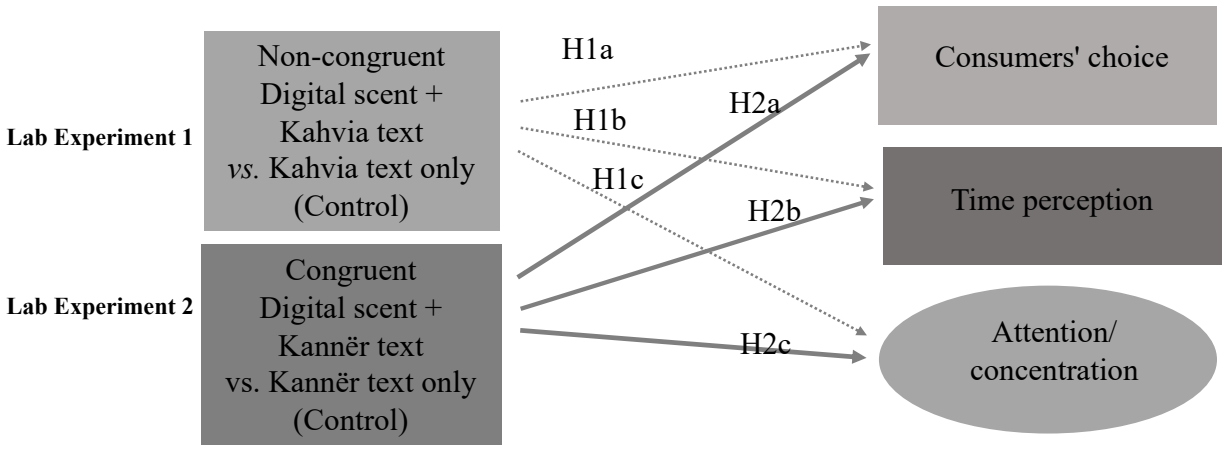
Congruence has also been shown to have a positive effect on concentration and time perception. It can increase concentration when there is congruence between the aroma and the context (Olofsson et al., 2017) and act as a distraction when there is no synergy between the aroma and the situation or product (Xiao et al., 2020; Spence, 2021a). In terms of time perception, a pleasant congruent aroma has been shown to make people stay longer in a room. It has also been found that when there is congruence between the scent and the product, there is a reduction in the perception of time (Spangenberg et al., 1996; Morrin, 2010; Véga-Gómez et al., 2020). Given that this study proposes the adoption of a non-food aroma with sweet, floral and powdery notes associated with a congruent product, it is expected that there will be less consumption of beverages during the coffee break. Therefore, we propose the following hypotheses:

When there is congruence between the digital scent and the product, both of which are non-food related:
(H2a) it reduces the choice of food.
(H2b) It increases the consumer's concentration.

(H2c) it reduces the consumer's time perception.

To test the hypotheses, we developed a conceptual model proposing two 2x1 laboratory experiments (Figure 1). In the first, we would test the perception of a non-food digital scent in a non-congruent context, where the product is a beverage that is highly valued by the public (coffee) and is even one of the options to be chosen during a coffee break (Study 1). In the second experiment (Study 2), we would test the interference of congruence by using the same virtual scent, but this time associated with a fashion brand. In addition, to get a clearer idea of the potential effect of the scent notes, we conducted a 2 x 1 field experiment using a perfume (chemical sense) with notes similar to the virtual one.

Figure 1: Research model



Source: Authors (2024)

3 STUDY 1

In the first round, we wanted to see if a non-food digital scent associated with a text presenting the gourmet coffee brand invented for the research (Finnish Kahvia) would influence consumer behavior. Although coffee is a beverage that is usually very popular in the reality of the sample (according to Axxus Institute, 2024, about 97% of the Brazilian population enjoys and consumes coffee), because we used a scent with floral and talcum notes, it was expected that there would be a reduction in coffee drinking behavior (H1a). As the stimuli were different (a stimulating product and a relaxing aroma), we believed that participants' attention would be divided (H1b). Although in the literature incongruence seems to be a factor that increases the perception of time (Spangenberg et al., 1996), it would

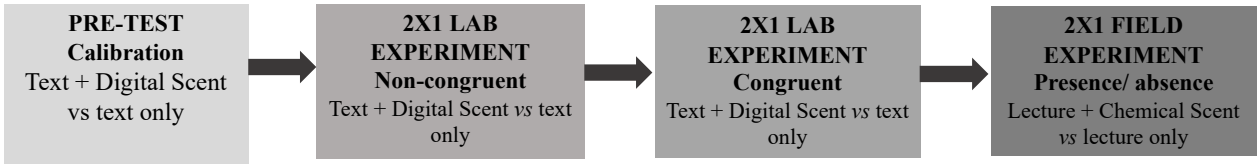
be interesting to see if the characteristics associated with the product had any interference or if people felt that it took them longer to read the brand presentation (H1c).

3.1 Design and procedures

To validate the hypotheses, we designed three rounds of single factor experiments (two in the lab and one in the field) with two conditions (access and no access) to the digital odor in the lab and the chemical in the field. Since we needed human participants to test the possibilities, we submitted the proposal and the mechanics to the Ethics Committee for approval (No. 5.127.450).

To minimize environmental confounding and to have some control over variables such as biological filters (e.g., gender and age), social, and cultural, we conducted the digital odor experiments in the laboratory and the chemical odor round in the field. The steps involved in this study, which was validated by the ethics committee, were as follows (Figure 2):

Figure 2: Sequence of experiments



Source: Authors (2024)

At all stages, especially in the laboratories, great care was taken with the mechanics. In the case of the environment, we insulated two laboratories that were more remote from the other rooms and had less traffic around them. The possibility of insulating the windows was also taken into account to reduce any possible interference from outside odors. These laboratories were sanitized with fragrance-free products on each collection day. The researchers also had to be carefully prepared. No perfume, clothing or hygiene products with fragrances could be used on these days.

As an additional precaution that we maintained in the post-COVID-19 context, tables, chairs, and computers were cleaned with 70º alcohol and the room was ventilated 40 minutes before the start of the daily collections. This procedure was repeated between surveys, with an interval of about 15 minutes between respondents.

In both the laboratory and field experiments, the samples were convenience and non-probability samples. In the case of the laboratory experiments, they were people who had access to the rooms used as laboratories in a university. This explains why in both laboratory experiments there was a concentration of participants with a student profile in a particular age group. The sample selection criteria were the same in both experiments, as was the olfactory trail of floral and talc notes. In the case of the field collection, the samples were employees of a real company attending an integration event on a Friday morning.

In the laboratory experiments, participants were asked to give their opinion on proposals for international brands to enter the Brazilian market. Both were created for the research and had different proposals. One was 'Kahvia', a Finnish gourmet coffee brand, and the other was 'Känner', a slow fashion brand from Sweden. If the person approached was interested in participating, they went with the researchers to the labs where they were asked to read and, if they agreed, fill out the consent form required by the Ethics Committee (TCLE) on the Qualtris survey online. Initially, we raised two points that would make it impossible for them to participate: if they were under 18 and if they didn't agree with the consent form.

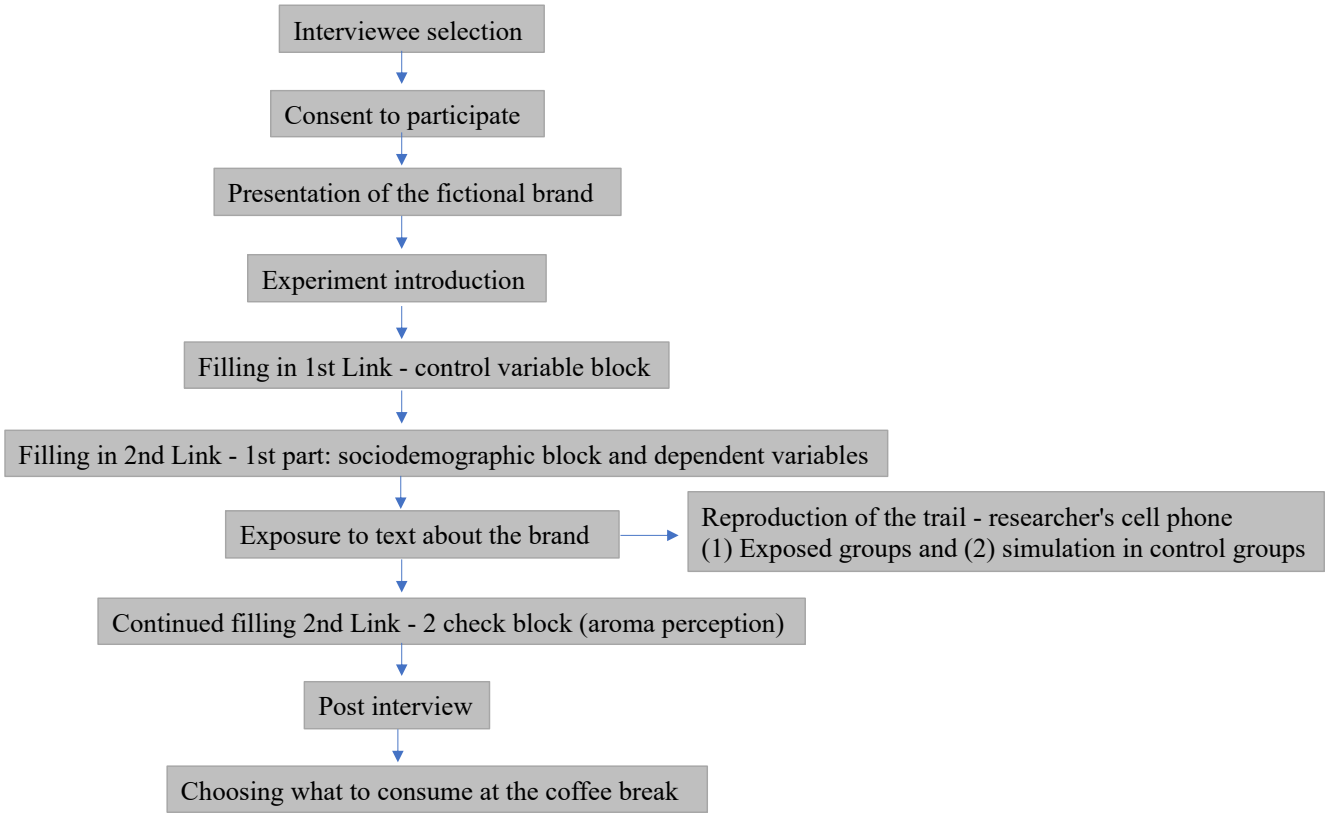
The experiment had two hiperlinks. In the first, we checked some of the possible physiological control elements, such as pregnancy, respiratory diseases, use of medications acting on the central nervous system and whether they had been in contact with the COVID-19 virus in less than 2 months (Majid, 2020; Niedenthal et al., 2021; Ornati & Kalbaska, 2021; Dal Bò et al., 2022; Spadera et al., 2022; Bochicchio et al., 2023). In the second hiperlinks, we divided it into two phases: first, we checked aspects such as age and gender (Ellen & Bone, 1999; Chatterjee, 2022), descriptive information, ability to capture smells and first perceptions of the room environment. The test was blind, so people didn't know they were being exposed to an olfactory track because it didn't make a sound and the mechanics were the same whether they were exposed or not.

The mechanics of the collection and the instrument on Qualtrics with the items that interfered with the perception of the chemical aroma (therefore, offline olfactory) were evaluated by two academic professors from the fields of marketing and knowledge management. The addition of the filter to the participants' relationship with the aroma of coffee (on a 10-point scale between not tolerating it and liking it very much) was recommended because it was

one of the products and item a of the coffee break. The aim was to understand if this was a bias in the participants' choice of what to consume. Responses could be gathered via the researcher's computer, or the hiperlinks could be sent to the participant's WhatsApp to be answered via cell phone. The text introducing the brands was read on the computer in the lab.

Although the sample was non-probabilistic and therefore random, we tried to balance aspects such as age and gender as much as possible. Since we wanted to understand actual choice behavior, we adapted the mechanics of Gorn's (1982) music study. Thus, the study included a coffee break where the individual could choose between coffee, coffee with milk, orange juice, water, milk, and chocolate milk to drink so that we could check which item was chosen. The room used for this was at least 20 meters away from the collection laboratories and everything was prepared in advance to avoid the spread of aromas (especially coffee). The collection procedure was the same for both laboratory experiments (Figure 3):

Figure 3: Experiment steps



Source: Authors (2024)

In the first experiment, the context was not congruent, as the digital scent was combined with the coffee product. As mentioned above, the starting point for data collection was to agree to the ethics committee's terms of participation. After this step, if the participant was over 18 years of age, they completed the first hiperlink. Once this was completed, they immediately began the second hiperlink, which had to be completed in the laboratory because it involved perceptions of the environment. Remember that in both the first and the first part of the second hiperlink we checked for possible interferences with the perception of the aroma, such as biological control elements and some social, cultural and environmental elements. The second part was indicated in the Qualtrics questionnaire that the person had to inform the researcher that they were in that part. This is how we presented the text introducing the brands.

The texts varied in length. The one about Kahvia's gourmet coffee was 50 lines long and the one about Känner's slow fashion was 31 lines long. In the first case, which was not congruent, the reading time was between 2 and 3 minutes. In the second case, which was congruent with the scent, the reading time varied between 1 and 3 minutes. The test track was played on the researchers' cell phones, and for the purposes of the research, they said they were timing the reading time. The time between exposures was calculated from the number of repetitions of the scent track (cycles). After reading about the brand, participants were asked to answer the second part of the second link. At the end of the individual sessions, the participant was given a chocolate as a thank you and invited to have a drink during the optional coffee break (not wanting to consume anything was also a measured variable). The researcher recorded the individual's consumption choice in real time. In both laboratory experiments, the data were treated with analysis of variance and distribution.

3.2 Pre-test

To calibrate the mechanics and technology, we first ran a pilot with 25 participants. At this stage, we were also able to identify areas for improvement. Of the professors invited to contribute to the experiment, one recommended adding the item about the relationship with coffee. The marketing professor also suggested adjustments to the technology itself (as he felt it needed to contain more differentiated notes) and that the collection should be restarted. The olfactory trail was modified to include the aroma of talcum and a different intensity to be more salient, as it was essential for this experiment to check the perception of the

technology in order to measure the other aspects. We conducted two more tests, each with 15 people, to select the most perceived olfactory track.

After adjusting the digital scent, in a new pre-test with 21 people, 11 were exposed to the selected scent and 10 were exposed to the text about the brand presentation only. The sample was also by convenience. Female participation was slightly higher (58%), and the majority of respondents (59%) were aged between 18-25, and 62% were students. Although this was a blind test, meaning people were unaware that they were being exposed to a technology, 64% said they smelled an aroma which they described as 'sweet, floral and talcum powder'. This validated the mechanism and the technology.

3.2 Experiment 1 Collection

The sample had 50 valid responses, of which 20 respondents were exposed to the technology and 30 were the control group (not exposed). We proceeded with the experimental manipulation control. The items to check the perception of the technology were the same as in the pre-test. Of those who reported smelling something while reading the material, 100% were exposed to the digital scent ($\chi^2 = 27.238$, $p<0.000$), confirming the adequacy of the experimental manipulation. The mechanics were as described in the collection procedures.

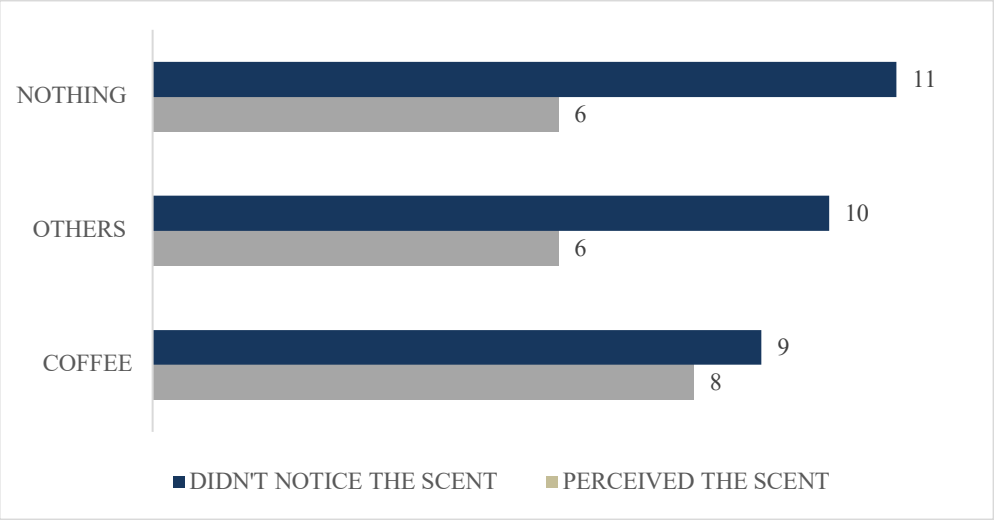
3.4 Results

Of the sample of 50 valid responses (20 exposed and 30 in the control group), of the 20 who reported smelling an aroma while reading, 13 described it in terms of the characteristics of the trail. Since the trail was presented in this context in conjunction with the gourmet coffee text, when we analyzed the words used to identify the aroma, we found that they were not associated with the text, but with the description of the trail's olfactory characteristics, such as "flower, talcum powder, sweet and pleasant".

In terms of the characteristics of the sample, there was a predominance of female participants (60%) and the identification of non-binary participants (6%), randomly distributed but without affecting the homogeneity of the group ($\chi^2 = 0.065$, $p=0.968$). In terms of age concentration, the majority of respondents (82%) were aged between 18 and 25 years ($\chi^2 = 4.058$, $p=0.541$), without this age group being concentrated in a single group. In other words, the age distribution is similar between those who felt the aroma and those who didn't.

When we look at the post-exposure choice behavior, there is no evidence that the technology inhibits any choice action. There was no significant choice of any particular item (Figure 4). Not even coffee, which was the product presented. The distribution of choices was as follows: 34% chose coffee, 32% chose nothing and 34% chose something else ($\chi^2 = 0.551$, p=0.759). When we introduced a floral and talcum powder scent that was not associated with food, it was expected that it would inhibit coffee consumption. We did not find this effect compared to the other options. As consumption was very similar between the exposed and control groups, **H1a was not supported.**

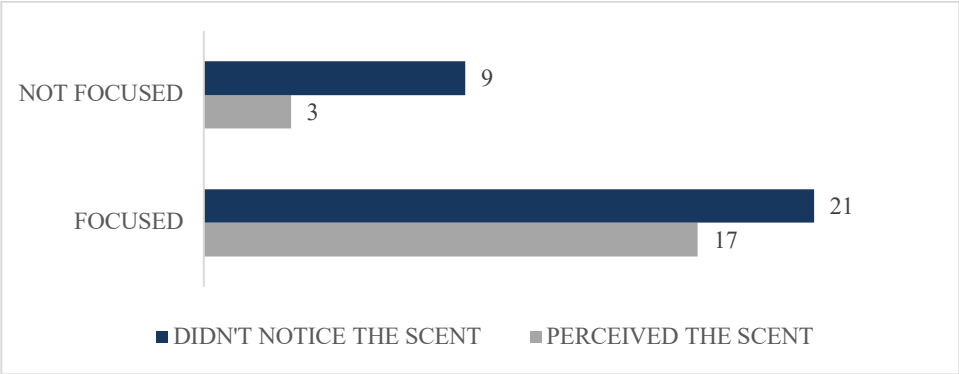
Figure 4: Consumer behavior



Source: Authors (2024)

In the case of the digital aroma, when it was not congruent, it did not prove to have a positive influence ($\chi^2 = 1.480$, p=0.477). Both in the group of those who felt the aroma and in the group of those who said they didn't feel the aroma, the level of concentration seemed to be similar, which means that the percentage of participants who said they were more attentive was the same in both groups (Figure 5). Therefore, **H1b cannot be confirmed.**

Figure 5: Focus x Perception of the scent



Source: Authors (2024)

We also tested the possible influence on time perception using the protocol recommended by Spangenberg et al. (1996) in their study of chemical fragrance. We compared the researcher-timed (real time) reading time parameter with the participant's self-reported time perception using a Student's t-test. We standardized both measures in seconds to capture possible variations and contrasted the results between the group of those who perceived the aroma and those who did not (Table 1). In this experiment, although the coffee product is perceived as stimulating, it was expected, as in the literature, that non-congruence would result in a greater perception of time for those exposed (Spangenberg et al., 1996). In addition, the fact that the aroma contained notes that were perceived as pleasant, soothing and even calming (flowers and talcum powder), it was thought that this would promote the feeling that self-reported reading time would be longer than in the control group. However, it turned out that the perceived reading time was actually longer than the actual reading time and that the exposed people actually took longer to read the text.

Table 1: Time perception t-test

Group Statistics

	PERCEIVED THE SCENT	N	Mean	Std. Deviation	t	Sig.
TIMED READING	YES	20	166.15	30.42	1.170	.248
	NO	30	156.47	27.47		
PERCEIVED READING TIME	YES	20	222.90	103.34	-.991	.327
	NO	30	259.00	139.12		

Source: Authors (2024)

In further analysis, a paired t-test was performed on each group analyzed to compare the perceived time with the timed time and to confirm the results of the previous table (see Table

2). However, when we analyzed the results, we saw that the effect was similar between those who perceived the odor (t = -2.390, p<.05) and those who didn't perceive the odor (t = -3.928, <.001). And although in practice we found that those exposed took longer to read, hypothesis **H1c was not supported**.

Table 2: Teste-T comparative

Group Statistics

	TIME PERCEPTION	N	Mean	Std. Deviation	t	Sig.
PERCEIVED THE SCENT	TIMED READING	20	166.15	30.42	-2.390	< .05
	PERCEIVED READING TIME	20	222.90	103.34		
DIDN'T PERCEIVE THE SCENT	TIMED READING	30	156.47	27.47	-3.928	< .001
	PERCEIVED READING TIME	30	259.00	139.12		

Source: Authors (2024)

3.4.1 Control Variables

As the sample in this experiment was made up of students, we didn't get any respondents with a pregnancy or lactation profile. As for the use of beta-blockers, anxiolytics or antidepressants, we identified 8 cases, coincidentally 4 in each of the groups. This type of medication had no significant effect on aroma perception ($\chi^2 = 0.397$, p=0.529). Regarding the possible influence of the COVID-19 virus in this sample, only 7 respondents had been recently exposed to the virus (contaminated or vaccinated). This did not prove to be a significant influence ($\chi^2 = 5.159$, p= 0.076).

We also examined the possibility that the relationship with coffee, as opposed to the technology in this non-congruent context, might influence the choice behavior of the consumers surveyed in this sample. To assess this, we used a 10-point agreement scale for the item "What is your relationship with coffee?" that was added to the questionnaire. To process the data, we agreed that a score of up to 5 would be considered "a little like" and above 6 would be considered "a lot like". We found that although 90% of respondents in both groups said they liked coffee, this did not influence their choice, as there was no greater number of people who chose coffee in this sample.

However, a Student's t-test (t=0.329, p=0.744) was performed to test for a possible confounding effect of coffee preference on non-food digital scent. Comparing the means of

those who did (μ= 8.75, sd =1.68) and those who did not (μ= 8.57, sd =2.08), the difference was not significant. This indicates that it did not affect the relationship.

Since the sample was homogeneous in terms of age and gender between the exposed and unexposed groups, we observed that these control elements had no effect on this experiment. In addition, we analyzed the average exposure to the digital scent among those who recognized the scent in order to identify any possible pattern. The average number of cycles for those exposed who identified features of the odor was 2.69.

3.5 Discussion

The aim of this experiment was to analyze the possible influence of a non-food digital scent in a non-congruent context, i.e. combined with a food product. We expected that because the aroma was more calming and associated with a perfume rather than the product, there would be a reduction in coffee consumption. Given that it is a favorite drink for this audience, reading about it might make the control group want to consume more. However, when assessing the influence of the aroma on the choice behavior of the exposed respondents, where a reduction in coffee consumption was expected compared to those who did not have access to the scent trail, we did not find a significant influence (χ^2 = 0.551, p=0.759). This result **did not allow us to confirm H1a.**

According to Olofsson et al.'s (2017) study on video games, as in Doucé et al.'s (2016) study on incongruent odors, the aroma can affect concentration, increasing or decreasing it depending on the type of stimulus. If the aroma is perceived as more pleasant and comfortable, usually when it has sweet, floral, or talcum notes, it would promote greater relaxation (Spence, 2021a). In other words, people would tend to be more relaxed. In the case of this non-congruent round, we found that the virtual aroma did not actually prove to have an effect on respondents' self-reported perceptions, as we found no significant differences between the exposed and control groups (□2 = 1.480, p=0.477). Therefore, **H1b cannot be confirmed.**

To analyze the perception of time, we adopted the metrics from Spangenberg et al.'s (1996) study and found that, as in the offline study, none of the groups had the "correct" perception of the time it took to read the text. In these authors' research, stimulating aromas such as

coffee made people feel that time passed more quickly. Pleasant, relaxing aromas such as flowers and talcum powder made people think that more time had passed. With a common virtual scent with similar characteristics to the second scent, it was expected that even if the product was stimulating like coffee, there would still be an increase in this sense of time compared to the real thing. To be on the safe side, we analyzed the values obtained in two ways to double-check the results. First, we performed a t-test, which showed that the average perception of time between those who were exposed and those who were not exposed was higher than that of the timed times. We found that those who perceived the aroma took longer to complete the activity, but since the sample was limited, more participants would be needed to verify this possible influence of the digital aroma on the time taken to complete the task. Therefore, to confirm that there were no major changes between the groups, a paired t-test of the conditions was performed, which also showed no significant differences ($t = -2.390$, $p<.05$). Therefore, **H1c was not confirmed**.

The biological control elements mentioned in previous studies as being able to interfere with the perception of aroma in the case of chemical olfaction, such as age, sex (Doty et al. 1974; Ellen & Bone, 1998; Croy et al, 2014; Chatterjee, 2022), pregnancy or lactation, the use of drugs acting on the central nervous system or COVID-19 (Majid, 2021; Spadera et al., 2022; Dal Bò et al., 2022; Ornati & Kalbaska, 2022; Bochicchio et al., 2023), in the case of digital non-food aroma, have not been shown to have an influence, at least in the non-congruent context.

Therefore, the next step was to see if there was a difference in the results obtained in a congruent context.

4 STUDY 2

The main objective of this experiment was to validate H2 of this study, which analyzes when there is congruence between the digital scent and the product. In other words, since both were non-food, it was expected that there would be a decrease in consumption of coffee break beverages (H2a). At the same time, it was proposed to see if there would be an increase in concentration in this context (H2b), even though it is a fragrance with pleasant and relaxing notes, which, due to the congruence with the coffee brand, would reduce the perception of time (H2c).

4.1 Design and procedures

In this study, we also carried out the single factor with two conditions (exposed and not exposed to the technology), except that in this round we wanted to check the possible influence of congruence (ethics committee approval no. 5.127.450). The olfactory track (with sweet, floral and talcum notes), the laboratories and the mechanics remained strictly the same as in the first experiment. The only change was that the product was a Swedish slow fashion brand, Känner, developed for the research. The gatherings were made immediately after the first experiment.

We then selected a new random sample, again taking into account the possibility of traveling to the laboratories on the university campus to participate. Again, we tried to balance the profile of the respondents in terms of age and gender. A total of 50 valid responses were obtained, with descriptive characteristics very similar to those of Experiment 1.

The text for the Känner brand was slightly shorter than for the Finnish coffee, at 31 lines. As we kept the mechanics exactly the same as in the first experiment, we kept the blind test structure. This was to ensure that people didn't know that we were testing an olfactory technology and thus to avoid response bias.

4.2 Results

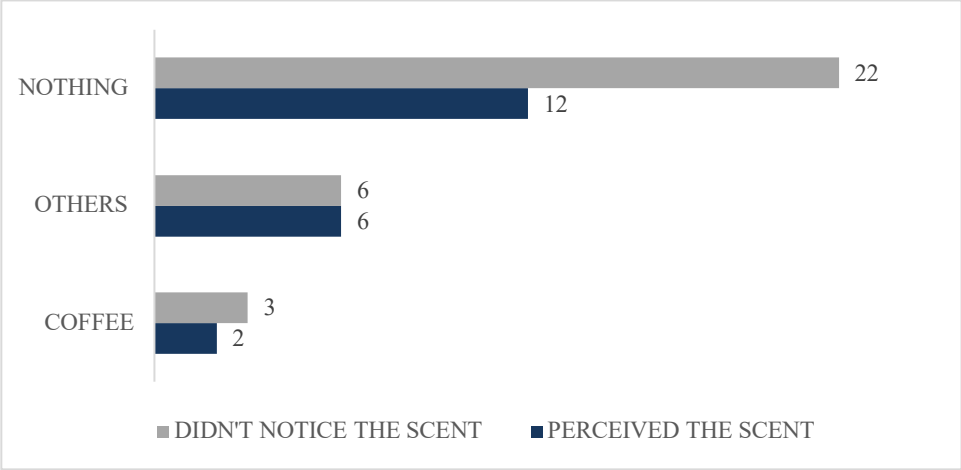
From the original sample of this experiment, with 60 valid responses, in order to standardize with the same criteria used in the previous experiment, we will analyze the data based on those who indicated that they smelled the aroma and had access to the scent track. In this way we obtained 51 valid responses, 20 participants who smelled the aroma and 31 participants who did not. Of the 20 who smelled something, 18 described it with characteristics of the digital scent using keywords such as cozy, flower, talcum powder (χ^2= 42.025, p<.000). 28 of the 31 people who were not exposed said they smelled nothing. This fact proves that the manipulation verifies the perception, identification and exposure to the digital scent.

Although the sample was randomly distributed, we identified a higher number of female participants (51.7%) and we also identified non-binary participants (5%) without affecting the homogeneity of the group (χ^2 = 0.223, p=0.895). In terms of age concentration, 72.5% of respondents were between 18 and 25 years old (χ^2 = 5.403, p=0.493). It is worth noting

that the age distribution was similar between participants who felt and those who did not feel.

In terms of post-exposure choices, we generally had a small number of choices (66%). 5 people chose water, juice or chocolate milk and only 1 person chose coffee. In the control group, 3 people chose coffee, 7 chose other beverages and 67% chose nothing (Figure 6). With these results ($\chi^2 = 0.806$, p= 0.668) **H2a cannot be validated.**

Figure 6: Consumer behavior



Source: Authors (2024)

In the congruent context, although the distribution of the sample became more balanced, the control filters such as gender (χ^2 de 0.223, p = 0.895) and age (χ^2 de 5.403, p= 0.493) had no significant influence between the groups. There were also no participants with a pregnancy or lactation profile. Regarding the use of beta-blockers, anxiolytics, or antidepressants, only 9 participants in total were using these medications, 5 of whom were exposed to the technology and 4 of whom were not. Among these participants, these medications also had no significant effect on their perception of the technology (χ^2 de 1.107, $p = 0.293$).

When we looked at the possible influence of COVID-19 on the perception of a calming non-food digital scent, there were only 18 participants, of whom 8 were exposed to the technology and 9 were in the control group. A Student's t-test was performed (t=0.951, p=0.346) and we found that the mean of those who perceived it (μ= 8.70, sd = 2.60) and the

mean of those who didn't (μ= 7.97, sd =2.74) were very close. This suggests that the virus did not have a significant effect on the perception of the technology.

To test the participants' perception of concentration, attention did not differ between those who smelled the virtual aroma and those who did not. The relationship between smelling the scent and the increase in self-reported perception of concentration was not significant (χ^2 =0.560, *p*= 0.454). **Hypothesis H2b was therefore not supported.**

To analyze the results in relation to the perception of time, we compared the variables between the perception of those who felt it and those who didn't, using a t-test. First, we found that the perceived time was not significantly different from the clocked time (Table 3). In addition, we found that although the actual reading time was longer in the exposed group, it was perceived as shorter by the participants. However, the control group had a higher time perception, i.e., although they actually read the text faster, they believed that it took them longer. Therefore, we believe that the congruence may have had a positive effect on those exposed to it, giving them the idea that the time was shorter, but we would need a larger sample to verify the influence of the digital scent on the actual time spent on an activity. Going back to our collected data, the perceived time for those exposed was longer than the timed time, so **H2c was not supported**.

Table 3: Test - t on perceived time

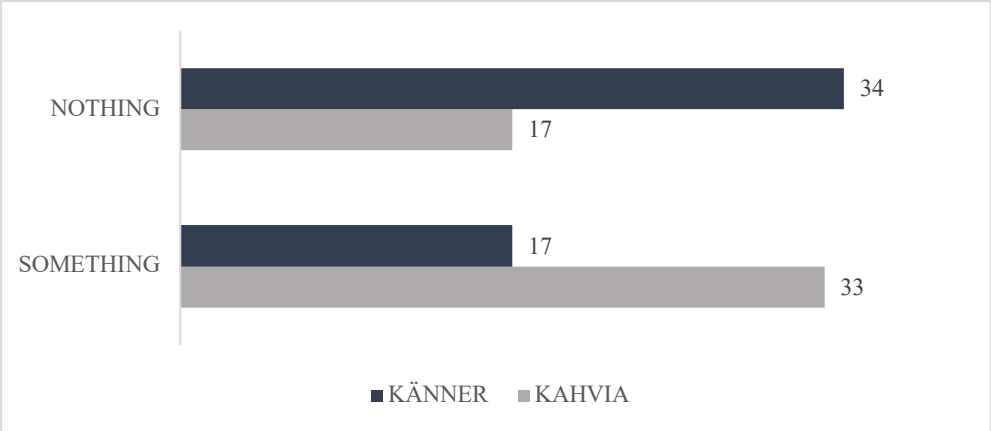
	PERCEIVED THE SCENT	N	Mean	Std. Deviation	t	Sig.
TIMED READING	YES	20	152.65	23.65	1.181	.243
	NO	31	143.81	27.55		
PERCEIVED READING TIME	YES	20	181.50	66.35	-1.272	.209
	NO	31	215.48	106.74		

Source: Authors (2024)

In this congruent context, we also performed a Student's t-test (t=0.329, p=0.744) as a control to check for possible interference of coffee preference with non-food related digital scent. We then compared the means between those who felt the aroma (μ= 8.75, sd =1.68) and the control group (μ= 8.57, sd =2.08). The difference was not significant and therefore the preference for the drink did not influence the choice.

To verify the possible influence of congruency, we conducted a comparative analysis of consumer behavior between the two experiments. when the scent was not congruent, it was expected that total coffee consumption would be reduced relative to the other options, even though the product was presented. this occurred when we observed the choices of the congruent base, where nothing was food, relative to the first round (Figure 7). The expectation was that in this experiment, where nothing (neither the text nor the scent) was food, there would be even fewer choices at the coffee break. This was indeed the case (χ^2 =10.778, p< 0.001). Considering that 90% of the respondents claimed to be coffee lovers, we can see that there was an inhibition of the desire to consume in the congruent context.

Figure 7: Comparative consumer



Source: Authors (2024)

The average number of cycles required to perceive the odor in this experiment was much lower: 1.90 or 2 cycles. With these results, we identified the need to verify whether the influence of a calming non-food digital scents on post-exposure consumption behavior is similar to that of chemical olfaction.

3.5 Discussion

In offline studies, we observed that congruence had the ability to enhance the influence of a smell, and it was proposed to see if something similar would occur with non-food digital scent (Doucé, 22; Brengman et al. 2022; Bochicchio et al., 2023; Bhardwaj et al., 2023).

The aim of this experiment was to analyze the possible interference of congruence. To do this, we analyzed the combination of non-food digital scent and a Swedish fashion brand developed for the study. Just to remind you, the practical selection phase was inspired by what Gorn (1984) did in his study and to test H2a, in which we proposed that there would be a greater inhibition of consumption of coffee break drinks compared to those not exposed. **H2a was not confirmed** (χ^2 = 13.392, p< 0.001). Comparing the choice behavior of the respondents in each round, we see that the fact that the product was coffee had some effect on the overall choice behavior, with greater consumption than when nothing was food-related.

The next hypothesis we wished to test was whether the addition of a hypothetical non-food related scent, as identified in the studies by Olofsson et al. (2017), Spence (2021a) and Spence (2021c), would influence respondents' self-reported perception of their concentration. These researchers, as well as Spangenberg et al.'s (1996) study, stated that the aroma would have a different effect depending on its quality. The one used in this experiment contained sweet, floral and talcum notes, which would be considered pleasant, comfortable and relaxing. However, participants' self-reports of attention did not show a significant difference between the groups (χ^2 =0.560, *p*= 0.454). Therefore, **H2b could not be demonstrated in this study.**

We believe that closely related to the issue of concentration was the perception of time. To analyze this, we again followed the metrics proposed by Spangenberg et al. (1996), where we compared data on how much time respondents thought had passed (performing an activity or feeling its duration) with actual time. We expected that the response to non-food digital aromas with softer notes would be a greater perception of reading time than for those not exposed. However, what we actually found was that although the text was the same for both those with access to the technology and the control group, the actual reading time was longer for those who felt the scent trail, while they felt it took less time than those who were not exposed. While these results encourage further research, **they do not prove the H2c of the study.**

In addition, we analyzed the possible interference of biological control factors such as age, sex, pregnancy, use of drugs acting on the central nervous system (Doty et al. 1974; Ellen &

Bone, 1998; Croy et al., 2014; Chatterjee, 2022) and COVID - 19 (Majid, 2021; Spadera et al., 2022; Dal Bò et al., 2022; Ornati & Kalbaska, 2022), which were the same as in Experiment 1. Again, we found that there were no significant differences between the groups.

One factor that could also influence choice behavior is the relationship with coffee. This is because it is one of the items available during the coffee break. Although the majority of participants said they liked coffee (as agreed in the first experiment), the means between those who were exposed to the aroma (μ= 8.75, sd =1.68) and those who were not (μ= 8.57, sd =2.08) were not significantly different. As the text was slightly smaller than the coffee text, the average number of cycles for those who smelled the virtual aroma was between 1.9 and 2 cycles.

Compared to the findings of the two laboratory experiments, we believe that an additional study is needed to see if the influence of the non-food related digital scent would be the same with a dispersed fragrance of the same notes. To this end, we conducted a 2x1 field experiment with two samples randomized between those exposed to a chemical fragrance similar to the adopted virtual aroma and the control group.

5 STUDY 3 - CHEMICAL ODOUR

The aim of this additional study was to see how people would behave in terms of food consumption when exposed to a chemical fragrance with notes similar to those present in the olfactory track of the previous experiments. In other words, we could measure the influence of the fragrance analogous to the virtual aroma only in the chemical sense, and thus understand whether choice behavior would be similar in both contexts.

5.1 Design and procedure

The starting point for this experiment was to find a fragrance analogous to the adopted calming non-food digital scent. To support this, the characteristics used by the participants in the technology calibration phases and also by the participants in the laboratory

experiments were: floral, talcum-like, sweet and pleasant. Some were more specific, associating it with notes of French lavender, talc and flowers.

Second, we chose a real company where we could conduct the 2x1 field experiment during a weekly time dedicated to learning about different topics and having breakfast, always in the same room. The food served on Friday mornings was always the same: French bread, butter, mayonnaise, cheese, ham, cake. The drinks were always soda (Coca-Cola), coffee, milk, and tea. By observing people's choices during these meetings for a month in advance (4), we found that the most popular flavors of cake were carrot with chocolate icing and chocolate with chocolate icing. We chose the chocolate cake. When we explained the experiment, the organization was flexible and allowed us to buy the same items and quantities for two consecutive meetings.

5.2 Results

The proposal was to carry out a 2x1 field experiment with two conditions (presence and absence of the non-food chemical perfume). In this first session, i.e. with the perfume, we had 18 participants, with a slightly higher number of males (56%) and ages between 20 and 60, with a higher proportion between 20 and 30 (35%), of which 4 were between 18 -25 and 2 were over 50.

The talk lasted about 20 minutes, and a random topic was chosen to justify everyone's access to the fragrance. The topic was 'how each of us can perceive the world around us differently'. So, each person was asked to describe in one word on a piece of paper the scent that had been sprayed on them. Some of the participants voluntarily held their perfume samples in their hands while describing. The most frequently mentioned characteristics of the fragrance were 'sweet, floral, talcum, cozy, flowers'. One person in the group had the flu, but despite having a stuffy nose, she said she smelled a sweet smell.

In the exposed group, when it came to eating the cake, which in the observations was the item chosen most quickly when it was chocolate, in this experiment it took about 9 minutes for the first person to take a piece, with a window of another 3 minutes for the second piece. When we asked people why they didn't want to eat the cake, they said they didn't feel like it. At the end of the experiment, there were 2 slices of cake left. The focus was on bread with

cheese and ham (22 out of 40 were consumed). As for the drinks, the most consumed were the soft drinks (6), 3 drank tea, 3 drank coffee with milk, 1 drank coffee and 5 people didn't drink anything. Regarding their enjoyment of coffee, 15 of the 18 participants said that they were big coffee drinkers and that they consumed the drink frequently, including at these events.

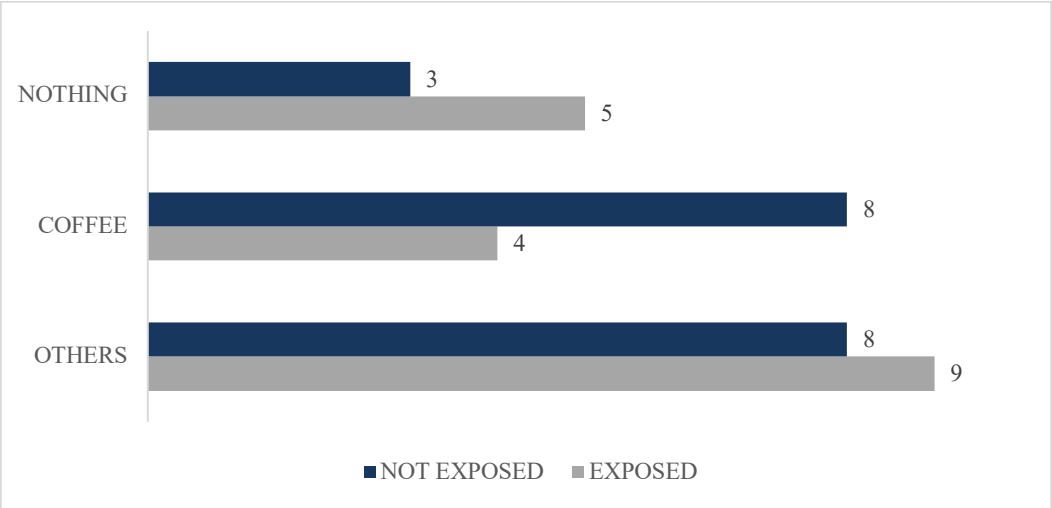
In the second experiment, which did not involve exposure to perfume, the topic was "On the Evolution of the Ford Production Process. The presentation lasted approximately 12 minutes. There were 19 participants in this sample, with a gender distribution similar to the previous one (53% males). The average age was again concentrated between 20 and 30 (37%), with four in the 18-25 age group and only two in the 50+ age group.

The first person to take the chocolate cake at the end of the presentation took less than 1 minute (27 seconds) and was soon followed by two more people. There was no cake left at the end of the experiment. The ham and cheese sandwich was the second choice, but it was well received (35 out of 40 were consumed). As for the choice of drink, the distribution was as follows: 6 soft drinks, 2 tea, 6 coffee with milk, 2 coffee and 3 didn't drink. In terms of affinity with coffee, 16 out of 19 said they were big coffee drinkers.

If we compare the two groups, we can see some changes. For example, if we look at the time it took to consume the cake. In the aroma exposure experiment, the participants took 8 minutes longer to choose the cake and there was a greater distance between the participants. The t-test ($t= 4.454$, $p< 0.001$) showed that the means of the exposed group ($\mu= 13.95$, $sd = 3.17$) and the control group ($\mu= 7.37$, $sd = 5.54$) were very different, which effectively proves that the difference in the time taken to start eating the cake is significant.

Looking at the beverage choice behavior, we found that quantitatively there was some difference between the groups, particularly in the choice of coffee (Figure 8). However, when we analyzed the data, this difference was not significant ($\chi^2 = 2.308$, $p= 0.315$).

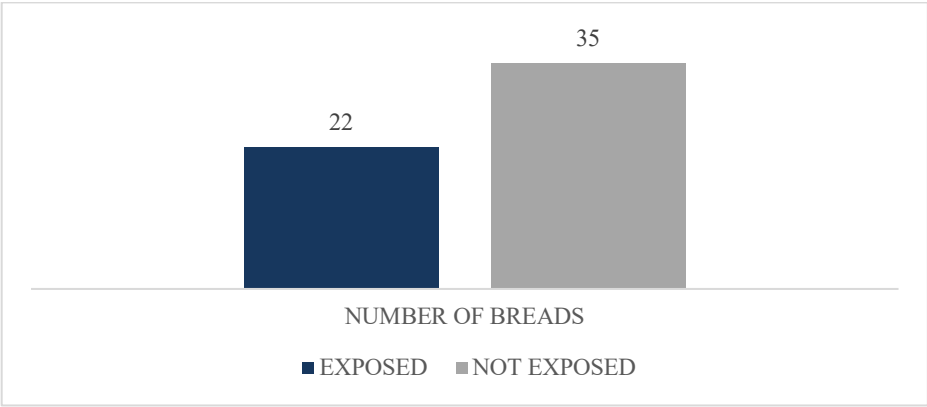
Figure 8: Comparison of drink consumption



Source: Authors (2024)

When we looked at bread consumption, we found that although there was no significant change in the number of people at each session, the amount consumed was significantly less in the exposed group (Figure 9). In absolute terms, the people who had access to the aroma consumed a total of 22 loaves of bread compared to 35 for those who did not ($\chi^2 = 37.000$, $p < .000$). In the end, there were 59% more breads in the second experiment.

Figure 9: Comparison of bread consumption



Source: Authors (2024)

An interesting point was that, as in Experiment 2, when the non-food digital scent was congruent with the product, respondents took longer to read the text. With the chemical scent, they spent more time on the page. The average difference was of 7 minutes (420 seconds).

5.3 Discussion

The field experiment allowed us to verify some interesting data about consumer behavior that we had found with the digital scent. Since the scent in this round was also a non-food scent with very similar characteristics (it mainly had notes of sweets, flowers, and talcum) to the virtual scent, we expected to better understand some of the responses we had obtained in relation to food choice (drink and food) and task completion time (Spangenberg et al., 1996; Eghil, et al., 2010).

The explanation time was about 20 minutes, a time that Spangenberg et al. (1996) and Eghil et al. (2010) suggest is sufficient for habituation to an odor. This may help in the interpretation of the results. For example, regarding the time to start eating. We could see that for the chemical odor, the differences in means between the exposed group (μ= 13.95, sd = 3.17) and the control group (μ= 7.37, sd = 5.54) were significant, which supports the difference of 8 minutes obtained by timing. In terms of time, we can also see that the time spent in the room during the experiment also varied. Those who had the chemical aroma were present for 7 minutes longer. We also observed that the sample who smelled the chemical perfume took longer between choosing the first piece and choosing the rest. There was a 3 minutes gap between them, whereas in the control group it was sequential (less than 1 minute difference between each).

The choice of beverage allowed us to see some differences in the numbers. It turned out that twice as much coffee was consumed in the unexposed group (8), whether milk was added or not, but the data show that this difference was not significant (χ^2 = 2.308, p= 0.315). Another point that we found interesting was the fact that bread consumption differed significantly.

While the exposed group consumed 22 breads, the participants who didn't smell the aroma consumed 35 (χ^2 = 37.000, p< .000). This is a significant difference of 59% more bread in the second round.

6. IMPLICATIONS AND RESEARCH AGENDA

6.1 Theoretical contributions

The main objective of this study was to investigate the possible influence of non-food digital aromas on consumer behavior, concentration, and perception of time. This research gap has been on the radar of researchers such as Spence et al. (2017), Olofsson et al. (2017), and Petit et al. (2019), who have pointed out the need to develop technologies that enable virtual smelling. Chatterjee, 2022 and Panagiotakopoulos et al. 2022 reinforce this need with the increasing use and applicability of online realities such as the metaverse.

There is already a tendency to look for solutions to enable virtual perception of aroma, texture and flavor to make the online experience more immersive, but there is still a need for more practical studies.

Much of this interest in academia is due to the fact that the sense of smell In other words, empirical research conducted offline has found some effects of aroma on the consumer, such as biological responses such as salivation (Spence, 2011), taste perception (Spence, 2015; Sandell, 2019a; Petit et al., 2021), quality (Biswas & Szocs, 2019; Berčík et al., 2021; Doucé, 2022), environment (Stenslund, 2015; Henshaw et al., 2016; Spence, 2020a) and also purchase intention (Lovelock et al., 2011; Lindstrom, 2012, Doucé et al., 2016; Véga-Gómez et al., 2020). These have highlighted the potential of olfactory marketing.

In addition to these results on the influence of scent on consumer behavior, we identified a research gap identified by other researchers: empirical studies should be developed to test new possibilities for enabling olfaction virtually, with the potential to be used online and in the metaverse (Spence et al., 2017; Suominen et al., 2018; Petit et al., 2019; Panagiotakopoulos et al., 2022; Doucé, 2022; Brengman et al., 2022; and Chatterjee, 2022).

Therefore, we proposed to test the feasibility of structuring the process of developing a non-food fragrance using a technological solution derived from cybernetics. To understand how the technology could work, we analyzed the physiology of the olfactory system. From the perspective of olfactory associations, we identified two complementary theories in psychology that could also explain olfactory functioning as a whole online, such as schema coding (Bartlett (1932) and the coding or content specificity model of Tulving (1982).
In a practical sense, we wanted to answer the question: Would non-food digital scents influence consumer behavior in virtual reality? Would the calming digital scent of flowers

and talcum powder influence food consumption? Would congruence play a role in influencing the effect?

To measure real choice, we were inspired by Gorn's (1984) study with the action of choosing something to drink during the coffee break after the collection. Since the experiments with different segments of the olfactory sense in "real life" showed that the congruence of the aroma with the product and with the other senses accessed would improve the consumption behavior of the respondents exposed to it, we conducted two experiments. In the first, we considered a non-congruent context between the non-food aroma track and the coffee product. In the second, with the same mechanism, laboratory and track, we only changed the product to the fashion brand to be congruent.

In parallel, to take a further step in understanding online consumer behavior in relation to olfactory marketing could be, we sought to verify whether the elements that control the perception of an aroma by the chemical sense would have an influence in the case of technology. In other words, would age, gender, pregnancy, medication use or COVID-19 influence the olfactory perception of people exposed to non-food digital scents? (Doty et al. 1974; Ellen & Bone, 1998; Croy et al., 2014; Majid, 2021; Spadera et al., 2022; Dal Bò et al., 2022; Ornati & Kalbaska, 2022, Doucé, 2022). In both experiments, these aspects have not been shown to influence the comparison of the results obtained between those who had access to the technology and those who did not.

The hypothesis that digital calming non-food scents would influence consumer behavior was not proven in any of the experiments. However, it did show potential to influence consumer behavior in that even in the first round where the product was coffee, which 90% of respondents said they liked very much, its consumption did not stand out compared to the other options. In the experiment where the product was non-food in addition to the olfactory trail, the total consumption of beverages was significantly lower than in the first sample, which could be an effect of congruence.

Although there were no significant differences in concentration and time perception between those exposed and those not exposed in either round, we were able to identify some

interesting aspects, such as the fact that in both contexts, those with access to technology took longer to read the text. Perhaps with a larger sample we could clarify these points.

In the field experiment, using a chemical scent with similar notes to the non-food digital scent, we saw that the group exposed to the scent took longer to eat something sweet and actually ate less than the control group. The time spent in the room was also longer for the exposed group, highlighting the need to investigate this aspect of digital scent with a larger sample in future studies.

6.2 Managerial implications

For management applications, this study extends the possibility of developing alternatives for working virtually with olfactory marketing. In this study, it has been proposed to test one of the technological solutions we have identified on the market, which has the greatest possible online applicability. Its mechanism consists in transforming sound tracks into olfactory tracks, accessible through any MP3 player. We have conducted two laboratory experiments to test the possible perception and impact of this technology. First, by combining it with a non-congruent product - a coffee brand - and second, as a congruent context, a fashion brand. In these rounds, we tested the potential influence of a sweet floral aroma and talcum powder on food choice behavior, concentration, and perceived time spent reading the material on each of the products. We also analyzed whether biological filters such as age, gender, pregnancy, use of certain medications, and the Corona virus would act as control elements in the perception and influence of a virtual aroma.

Understanding what might be affected and what to expect from a virtual aroma would help to understand the possibilities of replicating certain conditions. The biological filters did not interfere in either of the two laboratory experiments. Although we were unable to verify the influence of the scented track on concentration and time perception, we did find that in both samples, those exposed took longer to read the text. In other words, regardless of congruency, participants who smelled the scent took longer to complete the task.

In terms of choice, comparing the results of the two samples, in the context where nothing was food, there was less consumption at the coffee break than in the experiment where the product was coffee. This could be verified in a larger sample if the evidence of reduced food and beverage consumption is significant.

In addition, we conducted a field experiment, also 2x1 with two conditions, to understand some of the behavior of the laboratory sample, such as the reduction in consumption when exposed to a non-food digital scent. In this case, we chose a perfume with the same notes as those indicated in the olfactory track (sweet, floral, and talcum powder) and found that it not only delayed the consumption of sweet items, but also reduced overall food consumption. We also observed that participants stayed in the room longer due to the pleasant and comfortable aroma, consistent with studies such as Spangenberg et al. (1996), Eghil, et al. (2010), and Spence (2021).

We have identified some limitations and opportunities that we believe would be interesting to explore in further research. Based on these findings, we can also identify new opportunities to explore the possibilities of online olfactory marketing.

6.3 Limitations and future research

One of the major limitations was the sample. As this was an unpaid study, it was difficult to find volunteers willing to come to the ethics committee reviewed laboratories. This limited the number and diversity of participants. Another concern was that as the research was conducted in rooms on a university campus, the profile of the respondents was very concentrated in a certain age group and socio-cultural context. This may, in a sense, encourage a bias in responses and similar perceptions.

A second limitation was that the sample yielded few valid responses in each experiment. We had to exclude respondents under the age of 18 who did not accept the conditions of participation. Another issue concerns the scent trail used. As it contains sweet, floral and talcum powder notes, it could easily be perceived as a perfume. This could be confusing and be perceived as coming from the researchers or the environment itself. The intensity should be more obvious. As it's not a food smell and could be associated with the environment, it would need to be more prominent to stand out. We could recommend testing this type of fragrance in other contexts, such as open spaces, or testing the perception of smell that cannot be associated with food, perfumes or environmental scent. It would also be possible to measure this technique using an olfactory track with intense odours but with negative associations, such as fish.

Another aspect that could be analyzed is to compare the influence between technology perception and cognitive action (through olfactory memories). It would be necessary to develop a comparative study between the two elements and see if, between technology and, for example, lexical cognitive triggers, which would have a greater influence on consumer behavior and what role congruence would play. In the same study, it would also be possible to see if there is a dominance relationship between these stimuli (Lwin et al., 2016; Jang & Lee, 2019; Doucé and Adams, 2020).

Then, to test the possibility of online adoption, we recommend investigating whether images, sensory videos, augmented reality, and virtual reality would influence the perception of the scent trail. In online cases, we also believe it would be appropriate to explore whether interaction (exposure to browsing websites or social media) and culture (social reality) would influence the perception of the technology and its performance. This could help us to understand whether lexical or neuromarketing cognitive triggers would have a greater or lesser effect on the perception of technology on the web, for example via MP3.

With regard to the nature of the technology tested, given that it proposes to act directly on the nervous system by converting a mechanical sense (hearing) into an aroma, it is necessary to understand whether the identification of an aroma would change if there were a fictitious 'odour source'. This proposal arose from the observation that, during data collection, many respondents instinctively gestured to locate the source of the aroma, flared their nostrils as if searching for a scent that their brain might have identified. Given that this technology aims to act unconsciously, directly on the limbic system, and may 'require' a re-education or adaptation in how the aroma is perceived, the ethical issues surrounding its use need to be analyzed. Considering that in some cases the possibilities are entirely virtual (the technology used in this study was inaudible), it is essential to understand the limits and regulations for its online adoption and to assess its large-scale effects.

We also recommend developing studies with designs that compare collected data sets. As this was the first round of experiments with a non-food related digital scent, we chose a more controlled model (2x1) to minimize influences on respondents' perception of the digital scent. In future studies, it would be interesting to adopt a 2x2 model and compare the data sets to verify any divergence in the influence of the virtual aroma depending on the context.

In addition, a comparative study between this olfactory technological solution and other proposals would be valuable. First, we propose a comparison with the solution proposed by Niedenthal et al. (2021), which is a radiofrequency device for olfactory re-education after sensory loss, with the possibility of 3D printing.

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PART 4

"Alice Kingsley: This is impossible.
The Mad Hatter: Only if you believe it is."
Lewis Carroll

4. CONCLUSIONS

In the fourth part, we summarize the main findings of our studies and highlight their implications. We also acknowledge their limitations and offer suggestions for future studies. Finally, we provide a list of references cited throughout this document.

4.1 Main objective conclusions

The general objective of this thesis was to verify if the digital scent would influence consumers' attitudes, behaviors and perceptions. In this sense, first of all, we were able to prove through the experiments that the digital scent was perceived by the consumers. We were also able to verify that the food scent (coffee) had a greater influence on consumer behavior than the non-food digital scent (floral and talcum), in terms of the influence of olfactory tracks.

In the first rounds of experiments discussed in article 2, we proved that, although it does not influence attitudes, stimulating food digital aroma does influence consumer behavior. In the laboratory experiments in article 3, we were not able to prove this influence, but we found that there is evidence that calming non-food digital aroma reduces consumption of beverages, including coffee, even when the product analyzed is that beverage (which more than 90% of the sample said they liked a lot).

4.2 Specific objective conclusions

One of our specific objectives was to see if digital scent had an impact on consumers' intentions and actual behavior when choosing a beverage. In this regard, in the experiments conducted in the first article, with the digital food scent of coffee, we found no significant influence on consumer attitudes. In the other hand, we found an increase in coffee consumption, regardless of whether the context was congruent or not. In other words, even without reading about the gourmet coffee brand, participants exposed to the olfactory track chose to drink this beverage during the coffee break.

This suggests that the digital scent may be influencing the person's decision to take this action, which is consistent with the findings of previous offline research. In this way, our study provides some preliminary evidence of the potential for digital scents to actually influence consumer behavior, even in the absence of product-scent congruence.

In the third article, we tried to analyze the specific objectives that sought to understand whether, in the case of a non-food digital scent, it would be able to influence food consumption, consumers' concentration and their perception of time. For this purpose, we chose an olfactory track with floral and talcum notes. Although we did not obtain significant results validating the hypothesis that the non-food digital scent reduces beverage consumption, we did find evidence of this reduction. This was particularly true when we analyzed the numbers comparing the choices when the product presented was Kahvia gourmet coffee and when it was the slow fashion brand Känner.

In other words, in this case, the choice of beverages was lower in the congruent context than in the noncongruent context where the product was food-related. This result calls for a new study with a larger sample in future research.

For the scent track with notes of flowers and talcum powder, we did not find a significant influence of the digital scent on the consumers' concentration and perception of time. However, we did find that those exposed to both the congruent and non-congruent contexts spent more time performing the activity than those in the control group.

Congruence has been shown to potentially influence consumer behavior when the scent track is food-related and stimulating. In the case of a calming non-food digital scent, congruence did not prove to have a significant influence on beverage consumption, although it did provide evidence of this effect. When we compared the effect of congruence on choice behavior and time to complete the activity between the chemical and virtual scent, we found that the expectation of a reduction in food consumption was reasonable, inviting us to conduct another experiment with a larger sample.

4.3 Limitations and future studies

We had some limitations. First of all, in the first study, the reality of accessing studies focused on olfactory sensory marketing in the online context has proven to be a challenging task. Part of this scarcity is due to technological limitations in the practical implementation of these studies. In addition to a meaning that has intensity as a formative element, which would be associated with proximity not characterized as something appropriate in the online context, the subjectivity of the meanings and associations that a scent can have for different people also increases the complexity of the study in more general environments (in terms of amplitude), such as digital. The second is access to the content in its entirety within the database. Some articles in journals with a good rating were inaccessible, preventing their inclusion in this study.

For the second study, we recommend that future research address limitations such as i) recruiting a more diverse sample to ensure generalizability of findings, ii) implementing pre-screening for specific preferences to control for potential bias, iii) refining question design to minimize the need for researcher interpretation, iv) exploring the use of non-food aromas to isolate the effect of digital scent from pre-existing preferences, and also v) examining the potential dominance between different sensory stimuli in non-congruent contexts.

Since we have used a text in this research, it is also important to know the comparative relationship with stimuli via images and sounds with the olfactory track. It's interesting to see if resources that access other senses, such as the visual sense with sensorially treated images (lighting, effects), augmented reality, virtual reality, and videos, would have the same type of dominance and/or influence on behavior in non-congruent cases.

Subsequently, to verify the possibility of online adoption, we recommend investigating whether the relationships and possible influences on the individual would be the same with the browsing experience (touch). In other words, it is necessary to explore whether interaction (exposure to browsing websites or social media) and culture (social reality) would have an influence on the perception of technology and its performance.

Regarding the design elements and technology, it may be necessary to investigate how these elements would be captured in the digital scent, since they act through the nervous system

and not the chemical olfactory system, or if there are other elements that should be considered in its design. For example, we didn't find a significant influence on intensity in those exposed to the olfactory track, did this element affect its perception or is its interference irrelevant since it is a neural action?

In the last study, one of the main limitations was certainly the sample. As this was an unpaid study, it was difficult to find volunteers willing to come to the ethics committee reviewed laboratories. This limited the number and diversity of participants.

A second limitation was the scent track used. Since it contains sweet, floral and talcum notes, it could easily be perceived as a perfume that could come from the researchers or from the environment itself. Also, the intensity should be more obvious, it would need to be more prominent to stand out. We could recommend testing this type of odor in other contexts, such as open spaces, or testing the perception of odors that cannot be associated with food, perfume, or environmental odors. It would also be possible to measure this technique using an olfactory track with intense odors but with negative associations, such as fish.

Another aspect that could be analyzed is to compare the influence between technology perception and cognitive action (through olfactory memories). It would be necessary to develop a comparative study between the two elements and see if, between technology and, for example, lexical cognitive triggers, which would have a greater influence on consumer behavior and what role congruence would play. In the same study, it would also be possible to see if there is a dominance relationship between these stimuli (Lwin et al., 2016; Jang & Lee, 2019; Doucé and Adams, 2020).

Then, to test the possibility of online adoption, we recommend investigating whether images, sensory videos, augmented reality, and virtual reality would influence the perception of the scent trail. In online cases, we also believe it would be appropriate to explore whether interaction (exposure to browsing websites or social media) and culture (social reality) would influence the perception of the technology and its performance. This could help us to understand whether lexical or neuromarketing cognitive triggers would have a greater or lesser effect on the perception of technology on the web, for example via MP3.

With regard to the nature of the technology tested, given that it proposes to act directly on the nervous system by transforming a mechanical sense (hearing) into an odor, it is necessary to understand whether the identification of an odor would change if there were a fictitious "odor source". This proposal arose from the observation that, during data collection, many respondents instinctively gestured to locate the source of the odor, flared their nostrils as if searching for an odor that their brain might have identified. Given that this technology aims to act unconsciously, directly on the limbic system, and may "require" a re-education or adaptation in how the aroma is perceived, the ethical issues surrounding its use need to be analyzed. Considering that in some cases the possibilities are entirely virtual (the technology used in this study was inaudible), it is essential to understand the limits and regulations for its online adoption and to assess its large-scale effects.

We also recommend developing studies with designs that compare the collected data sets. As this was the first round of experiments with a non-food related digital scent, we chose a more controlled model (2x1) to minimize influences on respondents' perception of the digital scent. In future studies, it would be interesting to adopt a 2x2 model and compare data sets to verify any divergence in the influence of the virtual aroma depending on the context.

In addition, a comparative study between this olfactory technological solution and other proposals would be valuable. First, we propose a comparison with the solution proposed by Niedenthal et al. (2021), which is a radiofrequency device for olfactory re-education after sensory loss, with the possibility of 3D printing.

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