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The Aesthetic of User Experience: the Role of Affect and the Impact on Behavior

Tesi di Dottorato di: Marta Pizzolante
Matricola: 5116118

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PhD Candidate: Marta Pizzolante

Student ID Number: 5116118

Supervisor: Ch.mo Prof. Andrea Gaggioli

Co-supervisor: Prof. Alice Chirico

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Abstract

This doctoral thesis contributes to the domain of User Experience (UX), investigated through a psychological lens, emphasizing the role of aesthetics and affect in shaping user behavior.

From primitive tools to advanced technologies, human interactions with artifacts have evolved in complexity, encompassing a wide variety of objects and becoming integral parts of both personal and social life. This has been widely explored by several disciplines, including Design, Human-Computer Interaction (HCI), Engineering, and Visual Arts. However, to properly address this increasing complexity, we must investigate how these interactions extend beyond functionality to profoundly influence experiential dimensions, including perceptual, emotional, and cognitive aspects. In particular, the role of aesthetics in shaping our interactions with artifacts has yet to be thoroughly explored.

To achieve this, the thesis adopts the novel perspective of User Experience Psychology (UXP), which positions psychology as a core discipline in understanding user experiences. By examining the primary psychological processes involved in UX —perceptual/aesthetic, affective, and cognitive—this thesis aims at demonstrating how human interactions with artifacts can potentially represent instances of transformation.

Therefore, firstly, the concept of Transformative Experiences (TEs) is introduced. The thesis systematically reviews empirical literature on TEs, particularly those driven by artistic artifacts, and integrates these findings to identify areas for future research and practical application.

The aesthetic facet of UX is then analyzed according to the most current psychological perspective of the aesthetic phenomenon, which encompasses affective, cognitive, and behavioral components. Specifically, aesthetic emotions, distinct from other emotional categories, play a crucial role in shaping user interactions and long-term engagement with artifacts. The role of aesthetic in UX is explored through a first empirical study which investigates the relationship between aesthetic preferences and prosocial behavior in response to a specific artifact—architecture.

The fourth chapter clarifies the methodological choice of using Virtual Reality (VR) as the ideal medium to present artifacts to users and study aesthetic and affective responses in an ecological setting. VR is increasingly used to design prototypes of artifacts, present them to end-users, and promote new types of aesthetic experience. Supporting this, the second empirical study compares cognitive and affective evaluations of a design artifact, the *Graziella* bicycle, in both virtual and real environments. Additionally, the third study of this thesis examines how VR, as an immersive technology, can enhance the intensity of aesthetic emotions elicited by several famous paintings.

The thesis culminates in a comprehensive theoretical basis that integrates aesthetics, emotions, and technology within UX design, with a focus on the role of space. Space is an integral part of UX, especially as it is increasingly designed through virtual environments to recreate the natural usage contexts of artifacts. Drawing from Environmental Psychology and Visual Design principles, this final chapter provides actionable insights for enhancing aesthetic appreciation and overall user satisfaction in both physical and virtual environments.

Results from the last study underscore the importance of creating spaces that foster meaningful, memorable and impactful user experiences.

In summary, this doctoral thesis offers an exploration of UX as a psychological – and specifically aesthetic - phenomenon, emphasizing the critical role of affect in shaping these experiences and the transformative potential of user interactions. The theoretical contributions of this work include a potential new conceptual framework, which integrates several psychological theories and models to shed light on the mechanisms through which aesthetic impact affective responses, engagement, behavioral tendencies and overall experience.

On the practical side, the thesis provides actionable insights that can inform the design of more engaging and emotionally resonant UX. By highlighting the importance of affect and aesthetics in UX, the thesis encourages further exploration in this field, suggesting new paths for research and development. It also emphasizes the importance of interdisciplinary collaboration, integrating insights from psychology, design, art, technology, and various other fields to create more user-centered and emotionally satisfying interactions.

Introduction

Understanding User Experience Psychology

Since the dawn of humanity, our species has been defined by its ability to create and interact with artifacts, defined as any item, object, commodity or tool made or modified by human beings, typically to serve a particular purpose or function.

From the primal use of sticks for hunting or etching rudimentary graffiti on cave walls, to the current employ of sophisticated technologies, human-artifact relationship has continually evolved (Zupancich et al., 2016).

This evolution reflects not just technological advancement but also an enhanced complexity in the nature offered by those interactions. Increasingly, tools act as an extension of human abilities and intentions and shape our social life (Grudin, 2017).

From the artifacts that enrich our personal and professional spaces to the digital tools that connect us to the world, each interaction carries its unique complexities (Oulasvirta, 2008), influencing and reflecting experiential needs (Holbrook & Hirschman, 1982), affective and emotional responses (Derbaix & Pham, 1991), satisfaction (Burns, Barrett, Evans, & Johansson, 2000), social dynamics and cognitive processes (Desmet & Hekkert, 2007; Desmet, 2008; Laurans et al., 2012).

This broad spectrum of human-artifact interactions encompasses the interest of numerous disciplines, including anthropology, sociology, design, and, since the beginning of the computer technology era, human-computer interaction. However, in the world we live in, the most pressing questions about human-artifact interactions are not so much about (or not just) what the next tool we will have at our disposal, but what kind of consequences the interaction with that tool will have and how our experience of the world will be impacted.

To this regard, User Experience (UX) constitutes one of the most open approaches to the complexity of the human-artifacts interactions being designed and evaluated.

However, this approach, while seemingly intuitive, harbors issues that challenge its systematic and scientific analysis. Anecdotally, we might all grasp what UX refers to – the interaction and engagement with an artifact, product or service. This concept originates from early research in ergonomics and usability, gradually distinguishing itself as an autonomous field, underscoring the centrality of the user, marking a paradigm shift towards a user-focused approach (Singleton, 1972).

Ergonomics, traditionally concerned with optimizing human performance, laid the groundwork by focusing on physical interactions between humans and tools. This field's evolution introduced the concept of usability, emphasizing ease of use and efficiency as gold standards to evaluate artifacts. However, usability, which soon became a subset discipline of ergonomics, stressed the importance of user-centered design, ensuring that products not only met functional requirements but were also intuitive and accessible by a wide variety of users (Nielsen, 1993).

The transition from usability to UX marked a broader shift in focus. While the former concentrated on functional aspects, the latter expanded the scope to encompass the entire spectrum of user interaction, including emotional and experiential dimensions (Garrett, 2022).

This imperative to center the user within the UX domain leads to an interdisciplinary expansion, notably the incorporation of humanities into UX studies (Vermeeren et al., 2010).

Therefore, if already the traditional ergonomics - especially, originally, in the north-American definition of the discipline - recognized the need to evaluate the cognitive aspects of interaction, the contemporary understanding of UX, employing a multidisciplinary approach, underscores a shift towards an in-depth exploration of the user's needs, beliefs, desires, and expectations, recognizing these as central to the design and evaluation of artifacts (Law et al., 2009; Yablonski, 2024).

In this context, several scholars posit that psychology, with its dedication to the study of the human mind and behavior, is uniquely positioned to serve as the pivotal axis around which the other disciplines revolve to investigate UX (Hassenzahl & Diefenbach, 2010; Turner, 2017).

Hence, today, we are rapidly moving towards the emergence of a User Experience Psychology (UXP) that marks a significant evolution in the field of human-artifact interaction, establishing a specialized discipline dedicated to exploring, in an analytic and systematic way, the psychological mechanisms underlying user behaviors. This discipline would provide critical insights not only in understanding how users interact with artifacts but also why they interact in the ways they do and what are the consequences of their actions (Hassenzahl & Tractinsky, 2006; Hartson & Pyla, 2012).

To effectively examine UX from a psychological perspective, we need, firstly, to grasp what the concept of experience refers to, in psychological terms. While UX already incorporates experience as a psychological construct, some might argue that the term "User Experience Psychology" seems redundant. After all, UX inherently involves understanding and designing for user emotions, perceptions, and cognitive responses. However, this is a misconception.

Psychology has always focused on the investigation of human behavior and mental processes since its inception, dating back to when the human brain was referred to as the "black box" in “skinnerian” terms. Consequently, in the realm of UX, there's no need to delve into what "user" stands for, as it is implicitly understood. What is crucial is comprehending and capturing the concept of "experience."

In psychological terms, experience results from the complex interplay of perceptual/aesthetic, emotional, and cognitive dimensions. These dimensions together shape how an individual is likely to react to any given situation or artifact (Farrell, 1950). However, in the UX context, since individuals encounter a vast array of stimuli daily, making it increasingly challenging for any single interaction to stand out, these experiences need to go beyond the level of satisfaction or usability; they must be “transformative”, facilitating significant changes in the user's psychological state or life perspective (Pine & Gilmore, 1998). Therefore, UXP aims to understand which characteristics of our experiences with artifacts make them optimal and memorable and, potentially, transformative. In the next paragraph, we will explore the specific terms in which this occurs and examine why it is essential to study UX as an aesthetic phenomenon.

User Experience as an Aesthetic Phenomenon

As mentioned in the previous paragraph, recent trends within User Experience Psychology (UXP) indicate a growing focus on investigating the transformative potential of human-artifact interaction, aiming not only to meet user needs but to positively change users' behaviors and attitudes over time. While, on the one hand, it is true that the impact of an experience with an artifact can be only fully understood once it is lived through, on the other, we can identify several assets that invite, elicit, or facilitate transformative experiences (Gaggioli, 2019). As such, human experiences with artifacts can be transformative in creating products and design experiences that inspire significant, positive changes in users' lives (Garrett, 2011).

In this context, the chosen perspective for investigating the transformative potential of human-artifact interactions, within the UXP framework, is the aesthetic dimension. The rationale behind this choice is grounded in the historical evolution of the discipline and within the psychological literature on UX, which suggests that our interaction with artifacts is primarily aesthetic (Zhou & Fu, 2007; Mahlke, 2007). Aesthetics is intrinsic to our experience of artifacts and cannot be thought of as separate from any given product. Consequently, it should not be regarded as a distinct category in our interactions with artifacts but rather as the primary one, wherein our perceptual, affective, and cognitive responses are profoundly elaborated.

Additionally, recent trends in empirical aesthetics are acknowledging the transformative potential of art and aesthetics. New models of aesthetic experiences encompass and integrate all perceptual, affective, cognitive, and behavioral components, which are the fundamental facets of interest in this research. These components are crucial as they offer a comprehensive understanding of how aesthetics can significantly influence and shape our relationships with artifacts, thereby facilitating transformative design processes.

Thus, the main objective of this doctoral thesis is to focus on the study of UX as an aesthetic phenomenon, with a particular emphasis on aesthetic emotions and their transformative potential within UX design (Turner, 2017; Sauer & Sonderegger, 2022).

As already Donald Norman pointed out, "Attractive things work better" underscoring the principle that our engagement with and understanding of artifacts are significantly enhanced when they appeal to our aesthetic sensibilities. This observation aligns with the premise that UX is fundamentally an aesthetic experience, acknowledging that attraction is much more than pure aesthetic appreciation: it does not only promote ease of use of the artifact but also a more profound comprehension of the world around us through the artifact.

To fully understand the aesthetic facet of UX, it is essential to clarify what the term "aesthetic experience" refers to, from a psychological perspective. Traditionally relegated to philosophical domains, aesthetic experience has always been a highly relevant topic for psychology (Jacobsen, 2006; Roald, 2015). Starting from Freud's considerations on artists' personalities to the contemporary trends of neuroaesthetics, psychology has gradually expanded its investigation from the foundational definition of aesthetic experience and its components to the analysis of the potential benefits derived from it (Jacobsen, 2018; Skov & Nadal, 2020). Today, psychology can offer profound insights into the nature of such experiences.

Specifically, three relevant insights from psychological literature on aesthetic experience are useful for the current psychological analysis of UX in this thesis.

Firstly, aesthetic experience can be encountered through any type of artifact, whether analog, digital, artistic, designed, or even common objects without inherent artistic value. This underscores the ubiquity and accessibility of aesthetic experiences in everyday life and is reflected in the variety of artifacts considered in this work. Secondly, aesthetic experience is inherently complex, encompassing perceptual, affective, cognitive, and evaluative elements. It also involves factors related to motivation, behavior, readiness for action, prototypical experiential behaviors, and physiological responses. This thesis emphasizes the affective dimension, focusing on aesthetic emotions (Menninghaus et al., 2019). Emotions occupy a central place in UX, representing an underexplored dimension of human-artifact interaction (Mahlke & Thuring, 2007). These emotions are distinctive due to their deep intertwining with the sensory and perceptual qualities of an artifact. Beyond affective responses, the thesis aims to explore the connection between perceptual and affective responses and behavioral outcomes, investigating how experiences with artifacts can be transformative, significantly influencing users' engagement, behavior, and long-term relationships with the artifact (Silvia, 2012). Thirdly, psychological evidence on aesthetic experience emphasizes the importance of considering all components of such experiences, including contextual and spatial dimensions. In this context, space extends beyond its conventional architectural definition to encompass both the physical features of the environment where an artifact is placed and its experiential dimensions during interaction.

To conduct a comprehensive psychological analysis of UX—particularly focusing on aesthetic and affective facets, behavioral outcomes, and the integration of spatial components—Virtual Reality (VR) was employed as a consistent medium for artifact presentation. VR stands out for its ability to create immersive experiences that can intensify emotional responses in a controlled environment (Diemer et al., 2015). This characteristic allows for the elicitation and measurement of emotional responses under conditions where every variable can be managed (Felnhofer et al., 2015; Chirico et al., 2018). Not only the immersive nature of VR amplifies the emotional experience, making it more vivid and impactful, but it also provides a level of control and repeatability that is challenging to achieve in real-world settings (Riva et al., 2007; Susindar et al., 2019; Pavic et al., 2022). This aspect is particularly beneficial for replicating specific scenarios and experiences that are integral to understanding the complex nature of aesthetic emotions.

Furthermore, the increasing mediation of aesthetic experiences through immersive technologies, with VR at the forefront, reflects a broader trend in our contemporary digital age (Diodato, 2022). This shift towards virtual and digital realms as new media for aesthetic experiences necessitates an exploration of how these technologies shape our emotional and aesthetic perceptions (Gulhan et al., 2023).

Finally, VR is also increasingly prominent in the design and evaluation of human-product interactions, offering dynamic environments for designers and researchers to create prototypes of artifacts and simulate and assess the influence of design elements on UX (Choi & Chan, 2004; Camburn et al., 2017).

In summary, given that UX is increasingly focusing on transformative design and that art and aesthetic are progressively considered central instances of transformation, the first step undertaken in this thesis was to introduce a novel conceptual analysis of transformative experiences (TEs) and to exploit the potential transformative impact of human-artifact interaction focusing on the aesthetic dimension. For the former conceptual analysis, emphasis was placed on defining and distinguishing the characteristics of TEs from more basic types of experiences. The analysis explored the psychological mechanisms through which TEs induce significant changes and modifications in perceptions and behaviors, establishing a solid research background and outlining the implications of these findings. Additionally, a systematic review of empirical literature on TEs facilitated by aesthetics was conducted. This review assessed the aspects that define the transmission of experiences through user interaction with technology, art, and design, integrating findings to highlight potential areas for further research and application.

Secondly, to fully exploit the primary objective of this work—namely, the psychological exploration of UX as an aesthetic phenomenon encompassing its affective, cognitive, and behavioral dimensions—I conducted four empirical studies. These studies are interconnected and progressively build upon each other to provide a comprehensive understanding of the transformative role of aesthetic emotions in UX.

The first study investigates the ability of aesthetic experiences of architecture to stimulate prosocial behavior through aesthetic affective responses. This study serves as a foundation, establishing the link between aesthetic experiences and behavioral outcomes, specifically in the context of architectural artifacts. It highlights the potential of aesthetic experiences to influence not just emotions, but also actions.

Building on the importance of aesthetic emotions established in the first study, the second study examines the effect of immersivity on the intensity of aesthetic emotions elicited by several paintings. This study introduces the element of technology (immersive environments) and its impact on aesthetic experiences. It bridges the gap between traditional art forms and modern technological presentation methods, exploring how immersion can enhance or alter aesthetic emotional responses.

The third study follows the exploration of immersive technology's potential and analyzes the role of user interactions with designed artifacts. It explores the perceptual, affective, and cognitive responses of users interacting with a virtual/physical product (a bicycle). This study expands the scope from purely artistic artifacts (paintings) to functional design objects, providing a more holistic view of UX that encompasses both form and function. It also builds upon the previous studies by considering not just emotional responses, but also perceptual and cognitive aspects of the experience.

The final study attempts to integrate aesthetics, affect, and technology while focusing on the contextual dimension of space as an integral part of UX. It considers the impact of spatial design elements of a museum on visitors' experiences. This study synthesizes the insights from the previous three studies. The logical progression of these studies moves from establishing the link between aesthetics and behavior, to exploring how technology (immersion) affects aesthetic experiences, then examining user interactions with designed objects more comprehensively, and finally integrating all these elements in a spatial context.

The following sections will outline the thematic division of the chapters and the organization of theoretical and empirical contributions within them.

Overview of the dissertation

Considering the key concepts and the main objective outlined in the introduction, to comprehensively investigates UX as a psychological and specifically aesthetic phenomenon, this thesis is structured into five distinct thematic chapters.

The first focuses on the concept of transformation derived from experiences, particularly of an aesthetic nature, following a clear definition of what constitutes an experience.

The second chapter delves into the concept of User Experience (UX) itself, laying the groundwork for subsequent discussions. Following this, the third chapter, which represent the core theme of the thesis, examines the aesthetic facet of UX, highlighting its components and significance. The fourth chapter explores the use of Virtual Reality (VR) as the medium through the interactions with artifacts have been investigated in this work. Finally, in the last chapter, the thesis attempts to integrate aesthetics, affect, and technology of UX, framing all these elements in a spatial context.

Chapter 1. Defining Experience: A Psychological Perspective

The first chapter delves into the concept of Transformative Experience (TE). To fully grasp the current trends within User Experience Psychology (UXP), which highlighted a pressing need in the understanding of the transformative nature of our interactions with artifacts. To achieve this, it is essential to first understand the characteristics that make an experience potentially transformative. Recent scientific findings have highlighted the dynamic nature of experiences, emphasizing their ability to bring about significant changes in perception, cognition, and emotion. Therefore, this chapter explores the scientific literature on the psychology of experience, with a particular focus on its transformative potential.

In doing so, following the introduction to the concept of experience, the thesis will present a first conceptual and interdisciplinary analysis on TEs. This study explores the multifaceted nature of transformative experiences, drawing on insights from various disciplines to provide a comprehensive understanding of how such experiences, specifically from a psychological viewpoint, function, together with their impact on individuals. The goal is to dissect the concept of TE, examining their characteristics, underlying mechanisms, and the conditions that facilitate their occurrence.

Furthermore, as our interaction with artifacts is primarily aesthetic, I choose to exploit the potential transformative impact of human-artifact interaction focusing on the aesthetic dimension. Thus, the second study is a systematic review of the literature on transformative aesthetic experiences. This review aims to collate and analyze existing research on how aesthetic experiences, especially those involving art and design, can lead to

transformative changes in individuals. The focus will be on identifying common themes, methodologies, and findings in the literature, as well as gaps in current knowledge that could guide future research.

Chapter 2. Defining User Experience

The second chapter aims at establishing a comprehensive understanding of UX, which is essential for the subsequent discussions and analyses within the thesis.

The chapter starts by examining the traditional definitions of UX, primarily centered around usability and functionality. This exploration provides a primary understanding of UX but also sets the stage for a transition to more contemporary perspectives. Therefore, it evolves to encompass emerging views of UX, which place the user at the center. Here, the focus extends to the emotional and psychological aspects of user interactions with products and services, highlighting a growing recognition of the complex and dynamic relationship between users and artifacts.

A crucial part of the chapter is dedicated to exploring User Experience Psychology (UXP) and key facets of UXP.

Furthermore, the chapter starts to introduce the notion that User Experience is also an aesthetic experience. This section posits that aesthetics extend beyond mere visual appeal, profoundly impacting user perception and interaction. This discussion on the intersection of aesthetics and functionality in UX is a key aspect of the chapter, offering a view of how aesthetic considerations are integral to effective design.

The chapter ends with a case study on Norman's Teapots, providing a concrete example of the principles discussed throughout.

Chapter 3. Aesthetic Experience: the role of Emotions

The third chapter presents an examination of aesthetic as a crucial facet of UX.

The chapter begins with a brief historical overview of aesthetics in Human-Computer Interaction (HCI), followed by the evolution of the concept of User Experience (UX). This progression allows for a better contextualization of the emergence of aesthetics as a key element in the user experience.

Then, the examination goes on with the origins of the psychological systematic analysis of aesthetic experience, exploring how the scientific investigation of aesthetics has evolved over time, always from a psychological perspective.

This historical perspective provides a foundation for understanding the complexity and multifaceted nature of aesthetic experiences as they are investigated today in the scientific realm and as they could be used to

The chapter begins by delving into Freud's analysis of artists' personalities, which represent the first attempt in the psychological analysis of the "*creative mind*". It then examines the application of Gestalt theory and the pioneering empirical research in the field of empirical aesthetics, illustrating the integration of scientific

methodologies in the quest to understand aesthetic perceptions and responses. Also, an overview of neuroaesthetics, an emerging field that combines neuroscience with aesthetics, is presented.
However, central to this chapter, is the introduction and detailed exploration of a class of emotions, peculiar to aesthetic perception - that are aesthetic emotions.
The discourse on aesthetic emotions encompasses an examination of their distinctiveness from conventional emotional categories, and their intersection with broader emotional constructs. Moreover, the chapter expounds upon the impact of this class of emotions on human behavior. Specifically, the chapter further presents a first empirical study, which investigates the relationship between aesthetic preferences and their potential influence on pro-social behavioral tendencies.

Chapter 4. The Role of VR in investigating aesthetic experience in UX

In the fourth chapter, the thesis focuses on immersive technologies, particularly Virtual Reality (VR), and explains why they represent the ideal medium for investigating the aesthetic dimension of UX.
The chapter begins with a formal definition of immersive technologies, establishing a comprehensive framework.
Subsequently, the chapter delves into the exploration of the different types of XR technology (i.e, Virtual, Augmented and Mixed Reality), and the main psychological constructs associated with virtual experiences. A significant portion of the chapter is devoted to discussing the application of Virtual Reality in the context of User Experience (UX). This section examines how VR can enhance the UX by providing immersive, interactive environments that offer users more profound and engaging experiences.
To this regard, a second empirical study provides an empirical investigation into the comparative impacts of virtual and real environments on the user experience, particularly in the context of product design, is presented. The study focuses on how different environments influence users' perceptual, cognitive, and affective responses, offering insights into the effectiveness of VR in replicating and enhancing real-world experiences.
Furthermore, the chapter addresses the augmentation of aesthetic experience through VR. The discussion includes an analysis of how VR can facilitate a deeper emotional and cognitive engagement with aesthetic content, thereby enriching the overall aesthetic experience.
The third study presented in the thesis evaluates the effectiveness of immersive versus non-immersive VR technologies in the elicitation of aesthetic emotions derived from the vision of several paintings.

Chapter 5. Integrating Aesthetics, Emotions, and Technology in UX: a focus on Space

The fifth and final chapter of the thesis synthesizes the key themes of the research weaving together aesthetics, affective and technological dimensions and focusing on a last key dimension, integral and fundamental to fully exploit the psychological analysis of UX.

To this regard, the chapter draws mainly upon the contributions of Environmental Psychology. This background elucidates how environmental factors influence human behavior and experience, providing insights into how spaces can be designed to also optimize UX.

To clarify and enhance the discussion on the design of spaces, it specifically delves into the principles of Visual Design Principles, generally defined as “rules of thumb”; as such, principles are heuristic methods that help us make design decisions quickly. It critically examines the role of visual aesthetics in the creation of engaging and functional environments, emphasizing the importance of visual elements in evoking profound aesthetic and emotional reactions. The chapter concludes with a fourth empirical study, which evaluates the impact of specific design features in virtual environments on user experience. This analysis particularly concentrates on the emotional effect, aesthetic perception, and user interaction with these spaces. The aim is to understand how these spatial characteristics can enhance aesthetic appreciation and improve the overall user experience.

1. Defining Experience: A Psychological Perspective

"Experience, in its fundamental sense, is that which, by putting us in play ourselves, modifies us profoundly in a way that after having crossed, endured, traversed it, we will never be the same again: undergo an illness, mourning, joy, loving, traveling, writing a book, painting are "experiences" in the first philosophical sense, surely simple, but nevertheless trivial." (Romano, 1998, p. 197)

This chapter aims to enhance understanding of the concept of experience and its transformative potential by examining its emotional and behavioral consequences. In the first section of this chapter, the construct of "experience" will be introduced. This involves detailing the phenomenological and psychological frameworks that have historically shaped our understanding of how experiences are formed and perceived. I will draw upon classical and contemporary theories from philosophers such as Kant and Heidegger to modern psychological approaches. The second section will delve into the specific concept of "transformative experience", which delineates the role of this class of experiences in facilitating personal change. This section will outline how transformative experiences, distinct from ordinary experiences, have the capacity to profoundly alter an individual's perspective, values, and behavior. The mechanisms through which these experiences enact change will be explored, emphasizing the integration of theoretical models from environmental psychology and the latest empirical research. Finally, the transformative potential of aesthetic experiences will be highlighted, showing how these can lead not only to enhanced emotional engagement but also to significant shifts in personal growth and understanding.

Understanding experience is classically considered a philosophical problem or at least one which many philosophers have seized upon.

In his "Critique of Pure Reason" (1934), Kant asserts that experience is mediated by the mind's *a priori* structures, such as space, time, and the categories of the intellect. For Kant, these structures lay the groundwork for our every experience of the phenomenal world, effectively limiting our knowledge to the realm of possible experience and preventing us from direct access to the "things-in-themselves" (i.e., *noumena*).

Heidegger, on the other hand, in "Being and Time"(1927;1962), diverges from Kant's epistemological approach to focus on the experience. The philosopher considers it not merely as sensory or intellectual perception but as a fundamental openness of human existence (*dasein*) towards the world, a manner of being that is intrinsically linked to temporality and the finiteness of existence.

Later, phenomenologists critically started to examine the nature of experience, positing that the essence of human experience lies in its subjectivity, which signifies its inherent disconnectedness towards objects and phenomena (Smith, 2003; Mapp, 2008). This perspective shifts the focus from an objective analysis of the external world to the examination of the human *consciousness* (Chokr, 1992). Phenomenologists assert that to

understand the nature of reality, one must first investigate the processes through which consciousness constitutes and apprehends this reality. Notable figures such as Edmund Husserl (1913; 1929) and Maurice Merleau-Ponty (1952; 1959) have contributed extensively to this, with Husserl introducing the concept of *epoché*, a suspension of judgment regarding the existence of the external world to access the pure essence of consciousness, and Merleau-Ponty emphasizing the body's role as the primary site for and of perceiving the world.

Furthermore, Husserl himself asserted that the investigation of *experience*, as an object of inquiry, necessitates a rigorous analytical approach that intersects both logics, as a philosophical discipline, and psychology.

However, it was the American pragmatist philosopher John Dewey who firstly marked a significant transition towards the psychological study of experience. Dewey distinguished between a general experience and *having an experience* — a concept where an event, after running its course, reaches a determinate conclusion or a consummation, thereby standing out as particularly significant within the continuous stream of experiences (Dewey, 1934; 2008a). This distinction underscores the idea that not all experiences are of equal impact or significance with only some of them culminating in a profound sense of fulfillment or realization, marking a distinct moment of insight or closure.

Dewey further elaborated on the dimensions of experiences, emphasizing their dual nature as both active and passive, involving doing and undergoing (e.g., Romano, 1998; Waldenfels, 2011). In this dynamic interaction, individuals not only act upon their environment but are also shaped by their encounters within it, highlighting the inseparability of the individual and the role of the environment in the experiential process. Additionally, Dewey introduced the concept of the continuity of experience, suggesting that each experience is cumulatively informed by past experiences while simultaneously shaping future encounters. In Dewey's view, the aesthetic quality of an experience signifies its completeness and integration, where every element of the experience is aligned, yielding a sense of wholeness.

Building upon the contributions of Dewey, William James, as both a psychologist and a philosopher, was the first to conceptualize experience as the content of *consciousness*, emphasizing the fluid and continuous nature of it. Experience encompasses not only the individual's interactions with the external world but also the subjective realm of thoughts, emotions, and perceptions. This perspective marked a significant departure from an empirical account of experience, suggesting instead that the richness of consciousness's contents, as already partially theorized by phenomenologists, is central to understanding human experiences (James, 1863; 2007). James' work underscored the importance of the phenomenological quality of experience, asserting that the subjective interpretation and personal significance of events play a critical role in shaping human behavior and mental processes.

The introduction of consciousness and subjectivity into the realm of psychological study catalyzed a significant paradigm shift, yet paradoxically, it also precipitated a notable decline in interest within psychological research towards the exploration of experience.

The birth of experimental psychology, marked by Wilhelm Wundt's establishment of the first experimental psychology lab in Leipzig in 1879, signified a further shift in the transition towards an empirical approach to psychology, emphasizing quantifiable observations over subjective introspection.

Wundt viewed psychology as a science of immediate experience. In this respect, psychology differed from the natural sciences, which focused on mediated experiences: that is, on the objects of experience, conceived of as independent of the perceiving subject (Wundt, 1896, p. 3).Wundt thus contended that psychology should be seen as the very foundation of the humanities, because it had the universal laws of immediate subjective experiences as its field of study (Wundt, 1896, p. 4).

However, by prioritizing the measurement of observable behaviors and physiological responses, experimental psychology sought to place the study of the psyche on a scientific footing comparable to that of the natural sciences. This evolution necessitated a move away from a focus on consciousness, experience, and subjectivity, which, though integral to the human condition, presented challenges to empirical validation.

During the past several decades, psychology followed this trend that paradoxically contradicts the intuitions by Wundt, neglecting experience for the sake of behavior. Most of the research in this field throughout the current century focused on aspects tangential to the essence of lived experience, including behavior, attitudes, and decision-making, cognitive functions and performance.

It was with the advent of Positive Psychology, introduced by Martin Seligman and Mihaly Csikszentmihalyi (2000), that the focus of psychological inquiry was reoriented towards the inherently subjective nature of human life, that is *experience* - addressing a critical challenge within the discipline: the pursuit of objectivity in the study of subjectivity. Positive Psychology, by emphasizing human strengths, virtues, and factors contributing to individual and collective well-being and flourishing, marked a deliberate pivot back to the exploration of *subjective experiences*.

If the most important aspect of human life is the quality of experience, then the goal of psychology as a science must dictate methods appropriate to the description and understanding of subjective experience (Csikszentmihalyi 2014; 2018). Not only: while acknowledging the inherent variability of human experiences, either positive or negative, Positive Psychology must delineate parameters that define an "optimal" experience. That is, understanding what makes life worth living necessitates a deep dive into the qualitative aspects of human existence, thus revalidating the importance of the complexity of subjectivity in psychological research. This shift towards the subjective realm does not escape scientific rigor; rather, it integrates quantitative and qualitative methods to construct a more holistic view of human psychology, challenging the notion that subjective experiences are beyond empirical scrutiny. Firstly, optimal experience must be an ordered state of *consciousness*. The latter is composed of three functional subsystems: attention, which takes notice of information available; awareness, which interprets the information; and memory, which stores the information (Broadbent 1958; Pope & Singer 1978). When information is too little or too much, when it is random or incongruous, consciousness fails to operate. Within the broad range of ordered experience, *optimal* experience may be further defined in terms of two dimensions: what there is to do and what one can do. Part of the information that gets processed in consciousness consists in an evaluation of the opportunities for action present in each situation. At the same time, we also tend to be aware of what our abilities are in terms of these opportunities. It is convenient to call the first one of these two parameters of perception “challenges” and the

second “skills.” Optimal experiences are reported when the ratio of the two parameters approximates unity; that is, when perceived difficulty of challenges and skills are equal.

This is further exemplified by Csikszentmihalyi’s theory of flow (1975/2000). Flow, characterized by a profound sense of engagement, concentration, and enjoyment in activities, represents an optimal experience where the individual's skills are fully utilized, and challenges are met with heightened focus and creativity (Csikszentmihalyi & Csikszentmihalyi, 1988, Inghilleri, 1999; Massimini & Carli, 1988). This state of complete immersion and the alignment between challenge and skill not only contributes to immediate enjoyment and satisfaction but also promotes long-term psychological growth and well-being (Massimini & Delle Fave, 2000; Collins et al., 2009; Heo et al., 2010).
Thus, optimal experiences markedly contrast with everyday life-like experiences. They are characterized by their ability to transcend the "noise" of normal existence—distractions, stressors, and the often-automatic processing of day-to-day activities (Romano, 1988). In the context of this refined understanding, optimal experiences emerge not just as moments of enjoyment, but as experiences that possess the capacity to transform individuals and to reshape their perception about the self and the world (Delle Fave, 2009; Šimleša et al., 2018). Furthermore, a common characteristic of optimal experiences is that they often involve heightened emotional states (Fredrickson, 2000; Lyubomirsky, 2000). As the foundational principles of Positive Psychology suggest—particularly through the PERMA model posited by Seligman (2011) —the presence of positive emotions is crucial. These emotions act as indicators of flourishing or optimal well-being, signaling when individuals or groups are experiencing states that contribute to their growth and fulfillment (Livingston & Srivastava, 2012; Le Nguyen & Fredrickson, 2017). Invaluable contributions on the theme have been offered by Barbara Fredrickson’s research. Within her "*Broaden-and-Build*" theory, Fredrickson posited that positive emotions momentarily broaden attention, cognition, and behavioral repertoires, and that recurrence of these broadened states helps people gradually develop lasting and consequential personal resources (Cohn & Fredrickson, 2009; Fredrickson, 1998; Boniwell, 2015; Fredrickson, 2001). Negative emotions tend to narrow one's focus of attention, a response justified by the necessity to remove significant distractions and focus on potential threats. In contrast, positive emotions do not seem to be directly tied to specific actions. Instead, they are associated with less distinctly identifiable behaviors, suggesting a broader and more exploratory engagement with the environment (Boniwell, 2001; Fredrickson & Levenson, 1998). Fredrickson (2001) contends that the significance of positive emotions lies in their ability to complement negative emotions. While negative emotions tend to narrow one's focus, positive emotions broaden it, expanding both the scope of potential actions and the depth of thought. Consequently, individuals experiencing positive emotions gain a broader perspective, enabling them to perceive the world more comprehensively and to discern finer details in both internal and external contexts. (Fredrickson, 1998; Fredrickson, 2001). This leads to a lasting enrichment of physical, intellectual, and social resources, exemplified by resilience (Fredrickson, 1998; Fredrickson, 2001). Another function that has been investigated concerns their role in mitigating the effects of negative emotions, known as the "*undoing hypothesis*" (Cavanagh & Larkin, 2018). Indeed, emotions such as contentment and amusement help return

autonomic activity, previously elevated by negative emotions, to homeostatic levels (Fredrickson & Levenson, 1998). In summary, through the expansion of cognition and the construction of psychological, social, and physical resources, positive emotions contribute to an increase in individual well-being, thus fostering an upward positive spiral (Boniwell, 2015; Fredrickson, 2001). Those who experience more positive emotions demonstrate greater resilience and coping capacity (Boniwell, 2015; Fredrickson, 2001).

1.1 Being Transformed by Experiences

Once having established some of the main features of optimal experiences, it becomes crucial to explore the mechanisms through which individuals can not only achieve these optimal and positive emotional states but also sustain them in the long term. How do people lastingly change their lives for the better?

Here, we encounter the second critical concept underscored by Positive Psychology, and central to the work of this doctoral thesis - the concept of *change*. Change, within the context of Positive Psychology, is not about transient behavioral modifications. Instead, it involves deep, systemic transformation that promotes sustained well-being and growth (Aspinwall & Tedeschi, 2010). This concept of change is multidimensional, encompassing psychological, behavioral, and situational adaptations that individuals, communities, and societies undertake to enhance their quality of life (Seligman, 2002; Cohn & Fredrickson, 2010). For instance, the broadened awareness created by flow experiences or positive emotions help individuals recognize the value of the new behaviors presented by their experience of these states, and broadened thought–action repertoires may help them integrate these new behaviors into daily lives (Cohn & Fredrickson, 2010). As individuals build new resources for coping with problems or capitalizing on opportunities, they increase their trait-like propensity for experiencing optimal experiences in daily life, which in turn brings broadened awareness that makes future changes in behavior easier and more likely (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Fredrickson & Joiner, 2002). However, the pathway to positive change is not always gradual and incremental. Acknowledging that change does not always follow a slow and steady trajectory, it is essential to investigate the phenomenon of transformative experiences (TEs). These experiences represent a significant asset of the contemporary scientific exploration of the concept of *experience*.

The study of TEs, which in the last decade, has garnered the interest of a broad spectrum of scholars, including psychologists, emerges as a relatively recent area of inquiry. Despite its novelty, this concept draws also heavily from the scientific background of Positive Psychology and the groundwork laid by the study of optimal experiences. On the other hand, from the phenomenological standpoint and in terms of manifestation, TEs unfold in a manner distinctively different from their optimal counterparts. Unlike the gradual cultivation of optimal experiences through deliberate practice and engagement, TEs often strike unexpectedly, fundamentally altering an individual's perspective, values, or life trajectory in a moment (Paul, 2014; Miller & C' De Baca, 2001). This dichotomy between the gradual evolution fostered by optimal experiences and the abrupt, paradigm-shifting nature of TEs offers a compelling area of study for psychologists and scholars of human behavior, inviting a deeper exploration into the mechanisms that underlie significant life changes. The forthcoming

research provides a comprehensive, multidisciplinary examination of TEs, presenting an up-to-date, broad investigation into this field. Additionally, it delves into a specific subset of TEs, frequently overlooked, which are characterized by art and aesthetics as catalysts for long-term change. This exploration not only broadens the scope of our understanding of TEs but also highlights the significant, yet often unexplored, role that artistic and aesthetic experiences play in facilitating profound personal transformations.

1.2 Transformative Experience: A Conceptual Analysis

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1.2.1 Abstract

The concept of transformative experience (TE) has been widely explored by several disciplines from philosophy to neurobiology, and in different domains, from the spiritual to the educational one. This attitude has engendered heterogeneous models to explain this phenomenon. However, a consistent and clear understanding of this construct remains elusive. The aim of this work is to provide an initial comprehensive interdisciplinary, cross-domain, up-to-date, and integrated overview on the concept of TEs. Firstly, all the models and theories on TEs were reviewed to extract and analyze TEs' main components emerging from different disciplines. Then, this preliminary analysis was integrated with an in-depth examination of redundancies and particularities across domains and disciplines, to provide an integrated theoretical framework of TEs and a preliminary interdisciplinary operational definition of TEs. This examination, in turn, can help organize current research and theories, thus providing suggestions for operationalizing TEs as well as encouraging new interdisciplinary research endeavors.

1.2.2 All the Facets of Transformative Experiences: Toward an Integrated Picture

As early as 1622, an example of a memorable transformation can be identified, in the work of renowned sculptor Bernini, in his representation of the precise moment in which Daphne, while fleeing from Apollo, physically transformed herself into a laurel tree. In Ovid's Metamorphoses (Fantham, 2004), which inspired Bernini, transformation was conceived as a sudden and unexpected phenomenon, which irreversibly changes the state of things. More recently, in 1999, the Wachowskis staged one of the most famous transformative moments in the history of cinema, within their masterpiece "The Matrix." Red or blue pill? The main character, Neo, faced the choice of whether to continue living in his habitual illusory world, or to discover the true reality, thus, embarking upon a change with no way back.

Although these fascinating examples of transformation may suggest that this phenomenon could pertain more to the domain of art and fiction than to that of reality, evidence has shown that transformation – at least, several instances of it – may occur in any moment of an individual's life (e.g., Pearsall, 2007). The current COVID-19 pandemic could be taken as an example, in terms of events and consequences deriving from it that may be considered transformative. For instance, suddenly and unexpectedly, the pandemic has prompted people to change their daily routine as well as their personal view of the world, themselves, and of others (Marmarosh et

al., 2020; Vos, 2021). It is not unusual to read about people changing their lives, their jobs, divorcing, or moving away from home.

Anecdotally, many readers could identify with the above descriptions of transformative experiences (TEs), and several definitions and types of TEs already exist; nevertheless, an interdisciplinary cross-domain operational definition of this complex phenomenon is yet lacking. However, given the consequences of personal transformation, understanding its underpinnings, its elicitors, as well as the boundaries of this process has become an urgent scientific issue.

The complexity within the scientific investigation of TEs unfolds through three levels. First, the exceptional and fascinating nature of this topic has garnered the interest of different disciplines across the years (e.g., James, 1902; Maslow, 1962; Mezirow, 1978; Turner et al., 1986; Bruner, 1991; Calhoun and Tedeschi, 1995; Miller and C'de Baca, 2001; Brown, 2009; Stone, 2014; Gaggioli, 2015; Yaden et al., 2017; Kason, 2019), but this endeavor has yet to establish an integrated operational interdisciplinary definition of the term TEs. Specifically, most researchers agree that TEs can be conceived as phenomena able to engender long-lasting, irreversible, pervasive consequences on individuals' beliefs, perceptions, identity, and values (for an overview, see White, 1993; Brown, 2000; Paul, 2014; Gaggioli, 2016). However, this definition captures just one side of the process. Conversely, phenomenological features, elicitors or facilitating conditions enabling a transformative change are still open issues, which have been investigated separately.

Secondly, each discipline (e.g., anthropology, philosophy, psychology, neurobiology, education) has defined and investigated this construct at different levels of analysis. For instance, anthropology has defined this phenomenon at a meso-level of analysis, as strictly related to the specific experience of passage rites in which the central component would concern the break between past and future identities (Van Gennep, 1908). Philosophy has adopted a broader and a higher-level view of TEs' analysis by focusing on their definitory characteristics (Paul, 2014; Carel and Kidd, 2020). Psychology has addressed mainly the micro-level of analysis, by elucidating elicitors, correlates, and effects, which have been also used to categorize and distinguish various types of TEs. Finally, a recent neurobiological model by Brouwer and Carhart-Harris (2020) suggested specific neurological correlates and mechanisms. Education has adopted a separate view on TEs, mainly relying on transformative learning theory (Mezirow, 1997, 2000), which outlines the steps to make core frames of references malleable to change. Finally, a recent neurobiological model by Brouwer and Carhart-Harris (2020) introduced the construct of "pivotal mental states" (PiMSs), defined as "transient, intense hyper-plastic mind and brain states" (p. 320), to indicate unique states mediating psychological transformation. While the perspectives of various disciplines can contribute to the richness of the understanding of TEs, a synthesis of diverse insights can facilitate research efforts and results.

Different disciplines have focused more on some instances of TEs, instead of others. For instance, in clinical psychology, an increasing attention has been devoted toward traumatic experiences and, recently, to post-traumatic and post-ecstatic experiences (Calhoun and Tedeschi, 2006; Roepke, 2013). In experimental psychology the focus has been placed on the concept of complex emotions (Gaggioli, 2015; Chirico et al., 2016). In anthropology, there is a long tradition in the study of rites of passage (Van Gennep, 1908). In the field of

education, the focus has been on the process of transformative learning as achieved by means of disorienting dilemmas (Mezirow, 1997, 2000).

This has brought forth "varieties of transformative experience," which still need to be captured within a comprehensive picture including efforts to elucidate their underpinnings. Moreover, some efforts have focused only on specific types of TEs. For instance, White (1993) and Brown (2000) introduced a model on "exceptional human experiences" including near-death experiences (NDEs), encounter-type experiences, and out-of-body experiences (OBEs) analyzed at the psychological and phenomenological level.

In this conceptual analysis, we built upon these theoretical contributions, which were integrated with a more grounded approach, focusing on specific interdisciplinary and cross-domain types of TEs. By elucidating wide varieties of TE, we moved toward an integrated picture of these phenomena, involving a preliminary interdisciplinary operational definition of TEs, using the following methodology. First, all models, theories, and empirical evidence on TEs across specific disciplines (anthropology, philosophy, psychology, neurobiology, and education) and domains (spiritual, religious, technological, educational) were analyzed and integrated with specific instances of TEs that cannot be framed within a specific discipline or domain. Then, the analysis focused on distinctiveness and commonalities among these types of TEs. This turned into indications for achieving a preliminary integrated operational definition of the varieties of TE. Finally, new research directions to improve our understanding of transformative change were presented and discussed.

1.2.3 A Theoretical Overview

The need for the scientific study of transformation can be traced back to basic evidence. Some types of change can appear as different from others because they occur suddenly, unexpectedly, and without clear clues (Hayes et al., 2007; Paul, 2014). Crucially, these types of changes can deeply impact an individual's life in an unpredictable manner (Hayes et al., 2007); they also can occur in different cultures (Carel and Kidd, 2020), stages of life (Mezirow, 1997), and in response to different (potential) elicitors (Gaggioli, 2016) or apparently spontaneously (Hood, 2014).

Given the multifaceted, universal, and impactful nature of these phenomena, it is not surprising that several disciplines have sought to understand their essence, describing their functioning, their elicitors, and how to reproduce them. Here, first, we focus on specific disciplines that provide well-established accounts of TEs. Then, examples of acknowledged interdisciplinary instances of TEs are presented and examined.

1.2.3.1 Anthropology

An anthropological account of transformative change provided in Van Gennep's theory "rites of passage," can evidence the intrinsically paradoxical or ambiguous nature of TEs elicitors. Specifically, these unusual circumstances would be able to trigger a liminality space (Van Gennep, 1908) – "a transformative middle-space in which individuals find themselves in between past and future identities" (Gaggioli, 2015, p. 115) – enabling transformation. Turner expanded the concept of liminality by introducing the concept of liminoid spaces (Turner, 1974) – out-of-the-ordinary experiences – that can be found in leisure, arts, and sports, aside from

productive labor. Crucially, these are moments of freedom in which a "ludic recombination" (Turner, 1974, p. 61) of cultural factors occurs. Contemporary instances of liminoid spaces could be exceptional experiences far from the ordinary routine, which are highly memorable, very special, emotionally charged, and potentially life altering (Jefferies and Lepp, 2012, p. 38). For example, these could be unusual journeys (e.g., pilgrimages) (Kirillova et al., 2017) or extreme sports (e.g., white water rafting, spelunking, or base jumping) (Arnould and Price, 1993; Gaggioli, 2015). According to this perspective, then, there should be an out-of-ordinary elicitor/facilitating condition, acting as a liminoid space, to enable transformation. These moments would create a unique space as a potential for recombining existing cultural norms and factors into new patterns.

1.2.3.2 Philosophy

According to Paul (2014), out-of-ordinary elicitors should involve the choice to profoundly live a new experience, able to change our life in important ways. However, a TE entails opacity regarding the effects of being involved in such experiences. We do not know what it will be like since we dwell in a mid-suspended moment and we "only learn what we need to know after we've done it, and we change ourselves in the process of doing it" (Paul, 2014, p. 4). Specifically, the seminal model proposed by Paul (2014) suggested that each TE would encompass both an epistemic and a personal dimension. At the epistemic level, a TE would allow individuals grasping forms of knowledge unreachable before ("only learn what we need to know after we've done it"; Paul, 2014, p. 4). At the personal level, a TE can deeply change people' values, priorities, and self-conception deeply, thus transforming an individuals' identity ("we change ourselves in the process of doing it"; Paul, 2014, p. 4). This personal dimension consists of an irreversible cognitive shift leading to new frameworks of reference for differently viewing ourselves and others, thus, marking a clear "before" and "after."

Recently, Carel and Kidd 's (2020) work broadened Paul's conception on the role of human agency in TEs' emergence, by elaborating more on personal and contextual constraints and affordances that can limit human control over choices. The two scholars framed Paul's TEs within the category of (1) voluntary TEs, adding two more types of TEs imposed by life: (2) non-voluntary (e.g., being arrested and sent to Nazi concentration camps, as in the case of Primo Levi), and (3) involuntary TEs (e.g., saving a child who was being hit by a car remaining severely injured).

This dimension – namely, intentionality – allowed for a more detailed nature of TEs' elicitors. These inductors entail a dimension of contingency (i.e., the occurrence of casual and unpredicted situational conditions); vulnerability (i.e., the helpless and unavoidable exposure to many kinds of affliction); and subjection (i.e., the condition of undergoing a certain event with a lack of control over it). Moreover, this broader view on TEs included also negative and ambivalent forms of transformation. Finally, and importantly, according to this model, TEs cannot be seen just as sudden life-changing moments, instead, also as the apical result of a sequence of cumulative small ordinary changes.

1.2.3.3 Psychology

Contrary to Carel and Kidd's (2020) work – which also endorsed a gradual path to TEs – in the clinical psychological domain, Miller and C'de Baca (2001), drawing from the lexicon and models of quantum physics, preferred the label "quantum change," focusing more on the impacting nature of TEs. Specifically, a quantum change would consist of a breaking point in which a radical change must occur irreversibly. According to the two scholars, there would be two types of quantum changes, as two instances of TEs: (1) insightful quantum changes, that are mainly cognitive in nature and can be associated with insight; (2) mystical quantum changes, having a more emotional character and similar to mystical experiences (MEs) (Miller, 2004). These categorizations suggested the need for emphasizing the cognitive side over the emotional one or vice versa, according to the type of TE.

Building upon previous psychological contributions on TEs, White (2004) outlined some key psychological features of transformational change. TEs were defined as unexpected, brief experiences, usually remembered vividly, entailing enduring, and comprehensive effects (i.e., they represent a "revolution in character"; White, 2004, p. 465), in which the person acts more as a "recipient," rather than an "initiator" (p. 464), and which are positive in nature. However, this last feature has emerged as the most questionable.

For instance, the impacting - whether cognitive or emotional - nature of TEs was further elaborated by Calhoun and Tedeschi (2006) who focused on stressful and traumatic events as key elicitors of both negative (traumatic) and positive ("posttraumatic growth," PTG) changes that have "quality of transformation" (p. 2). (Calhoun and Tedeschi, 1995, 2006). Specifically, traumatic events can result in deep, sometimes irreversible, and negative change, in which suffering disrupts individuals' functioning. Moreover, traumas can impact individuals' schemas and beliefs, leading also to structured syndromes such as the posttraumatic stress disorder (PTSD). Crucially, the appraisal of these events, in terms of controllability, expectancy, and probability plays a key role in the process of coping with it (Kira, 2001). After the occurrence of those traumatic events, sense of time distortion and bodily distortion are considered precursors of posttraumatic disorder in specific circumstances (McNally, 2003).

Instead, PTG occurs when the individual, after facing a traumatic struggle, changes permanently and positively, going above and beyond resilience and finding durable benefits (Carver, 1998). PTG is defined as a "positive change experienced as a result of the struggle with trauma" (Calhoun and Tedeschi, 1995; Kilmer, 2006). This definition emphasizes the transformative quality of responding to highly stressful and/or traumatic events (Calhoun and Tedeschi, 2006). The intense and dramatic experience of trauma, indeed, fosters a powerful potential for psychological transformation, as it alters the normal stable structure of the mind (Grof, 2000). A person's pre trauma beliefs concerning the world as a just, benevolent, and controllable place can be replaced by new views, in which the negative and the positive effects of a traumatic event are combined, thus turning into a more elaborated, and complex conception of themselves and of the world (Park, 2004). In this sense, adverse events, or potentially traumatic events (e.g., developmental adversity, disability, and mental health problems) have been indicated as diversifying experiences – highly unusual and not predictable but being able

to push individuals "outside the realm of normality" (Ritter et al., 2012) – able to promote forms of creative adaptation in terms of reframing an experience using new cognitive and emotional lenses (Orkibi and Ram-Vlasov, 2019). In the end, it should be noted that not all traumas and PTGs are transformative: when they lead individuals to a relevant and permanent psychological transformation, they could be considered as TEs. Research on traumatic and stressful events has generally focused on individuals' transformation related to suffering and turmoil events (Kesimci et al., 2005; Kashdan and Kane, 2011), thus excluding perceived positive events as potential triggers of transformative growth.

Conversely, the framework of post-ecstatic growth (PEG) (Roepke, 2013) considers life events that enhance positive emotions, such as elevation and awe, as new possible triggers able to boost personal growth (Keltner and Haidt, 2003; Fredrickson, 2004; Taubman-Ben-Ari et al., 2012). Indeed, PEG concerns the idea of thriving also after highly impacting and positive experiences, giving as a result moral growth as well as deeper and closer relationships (Mangelsdorf and Eid, 2015).

Thus, in terms of factual post-event growth, there is a significant overlap in the perceived benefits of PTG and PEG, even though they are opposite in terms of valence and triggers (Roepke, 2013). However, for the purposes of this analysis, the valence of eliciting factors and outcomes is crucial to distinguish among these experiences, which consist mainly of the same processes. More specifically, triggers can have different valence and outcomes: (1) negative valence and outcomes for traumatic events that individuals were not able to accommodate and to cope with; (2) positive valence and outcomes for PEGs; (3) a negative valence but a positive outcome for PTGs, as in this case, individuals who lived a trauma were able to accommodate and to cope with it, gaining a positive as well as transformative outcome.

1.2.3.4 Human–Computer Interaction

Recently, the interest toward transformative and self-transcendent experiences (STEs) has grown also in the field of human computer interaction (Gaggioli, 2016; Kitson et al., 2019), and experience design (Blythe and Buie, 2021). Specifically, Gaggioli (2016) collected all these endeavors and developed a novel framework concerning how interactive technologies [e.g., virtual reality (VR)] can be used to elicit TEs. This is the transformative experience design (TED) model (Gaggioli, 2016). Transformative features associated to effective elicitors of TEs were identified based on three technological assets: (1) medium, (2) content, and (3) purpose.

Regarding the medium, immersive VR was suggested as the best candidate to invite these technologically mediated TEs by enhancing the ecological validity of even complex experiences in the lab, thanks to the sense of presence (Barfield and Weghorst, 1993; Riva et al., 2004, 2011). Specifically, VR can be (and it has already resulted as) a valid source for experiencing new worlds, for challenging and restructuring individuals' cognitive schemas, and as key mechanisms and correlates of TEs (Gaggioli, 2016; Riva et al., 2016; Chirico., in press). VR, indeed, allows individuals to alter their own bodily self-consciousness, providing the illusion of being placed in a different body. This is a useful asset for generating a sense of detachment from the actual body, as

in the case of OBEs, later discussed. Further, VR can also cause modulation and recalibration of time perception (Bansal et al., 2019), which is a common feature of TEs.

Crucially, drawing from Paul (2014) philosophical model on TEs, the TED model suggested that technology-based TE content should involve both epistemic and emotional affordances (Gaggioli, 2016). The former is included within circumstances designed to stimulate reflection and trigger insight (Gaggioli, 2015), as the artificial representation of disorienting dilemmas, recalling Mezirow (2000) pedagogical theory. The latter are defined as perceptual stimuli aimed to boost a deep emotional engagement by evoking feelings of interest, curiosity, inspiration, or awe.

Finally, the general purpose of a technologically mediated TE is the creation of new transformative possibilities. In this regard, such TEs should let individuals enter a space of liminality, as suggested by anthropology perspective, described, according to the definition of Turner (1974) as an unfamiliar and disorienting place that creates room for reviewing and deconstructing life meaning (Turner, 1985). In other words, allowing people to experience impossible internal and external realities through VR (i.e., by modifying their own body perception, or by letting them experience the body and the perspective of another person, or again by allowing them to explore impossible and unknown environments where physics' laws are violated) can lead them to destabilize their own mental schemes, deconstructing and reconstructing them in a new way. To date, this approach has been effective in eliciting specific transformative emotional states (Chirico et al., 2018a), as well as key micro-mechanisms related to the emergence of a TE, such as schema violations (Ritter et al., 2012).

However, further technological media can also be deemed as possible means to elicit TEs (Gaylinn, 2005). A more traditional medium, like movies, can be considered as a catalyst for personal and social growth and development (Morin, 2005; Kaplan, 2013). Transformative potential of movies has been widely explored in the education domain, by focusing on impactful masterpieces, such as Dead Poets Society1 (Spirou, 2016) or Billy Elliot2 (Schwarz-Franco, 2016). Finally, recently, also artificial intelligence (AI) has been proposed as a powerful technology able to trigger a societal change from a narrower sectorial level to a higher radical one, and always in an irreversible way (Gruetzemacher and Whittlestone, 2022). For instance, at the narrower level, the artistic domain has been increasingly influenced by different AI applications, including more collaborative forms of artistic production in music (McCormack et al., 2020), in figurative art (Schröter, 2019), and in fashion (Kautish and Khare, 2022).

1.2.3.5 Neurobiology

Brouwer and Carhart-Harris (2020) provided a neurobiological explanation for the emergence of PTG or traumatic potential consequences of transformation, by relying on the theory of dynamical systems (Kielhöfer, 2011). Specifically, they suggested that when an individual is involved in a long-lasting period of crisis (chronic stress), acute stress can trigger PiMSs – i.e., "transient, intense hyper-plastic mind and brain states" (Brouwer and Carhart-Harris, 2020, p. 320) – able to mediate psychological transformation. Crucially, also the

surroundings and the relational context were indicated as key factors interacting with the neurobiological system to define the quality and outcomes of a PiMS.

Pivotal mental states involve the serotonin system and its 2A receptor subtype (5-HT2AR). Various acute stressors consistently induce serotonin release, upregulating 5-HT2AR expression specifically in the cerebral cortex (Anju et al., 2010; Benekareddy et al., 2011; Godar et al., 2019). Further, direct stimulation of the 5-HT2AR can induce enhanced associative learning and psychological transformation, and it can be stimulated by both spontaneous extreme stress and relevant doses of psychedelic drugs (Joëls et al., 2006; Hefferon et al., 2009; Briere et al., 2015). The mechanisms underlying PiMSs would aid rapid and deep learning in situations of existential crisis, catalyzing psychological change when circumstances demand this. Thus, according to this perspective, learning – rapid and associative – was considered as an essential consequence of transformation, both stemming from spontaneous acute stress (as in traumatic and PTG experiences) or induced, for instance, by psychedelics.

1.2.3.6 Education

A full, comprehensive model of how transformation works and can be facilitated in the learning process can be found in the domain of education. Mezirow (1978) elaborated on the theory of transformative learning as a specific transformative process taking place in education and resulting in both a deep change in a frame of reference (Mezirow, 1997, 2000; Sawatsky et al., 2018) and a shift in thinking, which irreversibly alters the way individuals are and act (Coghlan and Gooch, 2011; Stone, 2014). The main elicitor of a transformative learning process can be a "disorienting dilemma" (Mezirow, 1997) (e.g., a field trip) (Herbers and Mullins Nelson, 2009) that challenges usual mental schemas. The disorienting dilemma would lead to a cognitive self-examination, along with feelings of guilt or shame. This leads to recognizing discontentment, thanks to which individuals can express and negotiate their change through discourse, moving to explore new options for roles, relationships, and actions. According to this view, emotions and feelings would provide not only the trigger to reflect critically, but also the substance on which to reflect deeply, so that the cognitive and emotional components become strictly related. Expected outcomes entail learners become "more inclusive, discriminating, open, emotionally capable of change, and reflective so that they may generate beliefs and opinions that will prove truer or justified to guide action" (Mezirow, 2000, p. 7). Main interdisciplinarity reported outcomes concern the following typologies: worldview; self; epistemology; ontology; behavior; capacity (Hoggan, 2016).

1.2.4 Grounding Transformative Experiences: Specific Instances of Transformation

Since not all studies on TEs can be framed within a specific discipline, we also chose a more grounded approach to capture all the studies conducted on this phenomenon, that is, we focused on instances of TEs occurring in specific domains and acknowledged as TEs. For instance, interdisciplinary works, combining psychological, neurobiological, sociological, and philosophical approaches, focusing only on a peculiar type of TE are discussed.

1.2.4.1 Religious Conversion

Within the religious domain, the transformation par excellence coincides with the phenomenon of religious conversion. Several sociological and psychological endeavors have successfully accounted for their emergence, features, underlying mechanisms, timeframes, role of the individual, and effects, but several open questions still remain (Snook et al., 2019). At a micro-level of analysis conversion is conceived as a core identity change (beliefs and personality). For instance, recently, it has been shown that religious conversion phenomena entail personality changes as a key effect (Stronge et al., 2021). In psychology, religious conversion has been investigated using the first-hand experiences of Tolstoy, Bunyan, Edwards (etc.). James (1902), in the The Varieties of Religious Experience identified two types of conversions. The volitional type concerned situations in which "the regenerative change is usually gradual, and consists in the building up, piece by piece, of a new set of moral and spiritual habits" (James, 1902, p. 189). The self-surrender type, emerged as an unconscious and involuntary surrender of the individual, after an intense internal struggle between one's aspirations and an internal hindrance. A paradigmatic example concerns the transformation of Saul (the persecutor) into Paul, the saint, as a Road to Damascus Moment, which stemmed from a supernatural experience of calling (Yaden and Newberg, 2015). Crucially, as in Carel and Kidd's philosophical model, also in William James' vision, it would be possible to identify a more gradual view of TE emergence. Anthropological accounts of religious conversion have acted as a key *trait d'union* among different disciplines, including psychology (Rotman, 2021).
Finally, mainly the sociological perspective, at a macro-level, focused on how cultural and social factors (e.g., economy, socioeconomic status, ethnicity, etc.) can influence the identities and beliefs of a potential convert (Snook et al., 2019). Generally, current accounts of conversion suggest an active role for the convert and a low impact of external, supernatural, and irresistible forces (Snook et al., 2019).

1.2.4.2 Self-Transcendent, Emotionally Complex, Peak, and Mystical Experiences

Spirituality is a wide domain of study, which goes beyond the realm of religion, even though the two overlap to some extent. Within this intersection, it would be possible to include STEs, which have a strong spiritual character and can be detached from any religious tradition. These experiences can be defined as transient mental states marked by decreased self-salience and increased feelings of connectedness (Yaden et al., 2017), although as for TEs, the definition of self-transcendence varies across disciplines (Kitson et al., 2020). When a STE is highly intense, it also shows a high transformative potential (Yaden et al., 2016a,2017). Potential conditions facilitating the emergence of these states can be paradoxical VR environments (Kitson and Riecke, 2018), psychedelic substances (Garcia-Romeu et al., 2015), spiritual instructions, dance, prayer (Garcia-Romeu et al., 2015), meditation (Hanley et al., 2020). Also peculiar social events, such as festival and parades, designed ad hoc, could bring forth self-transcendent shared experiences (Neuhofer et al., 2020). Therefore, STEs do not always occur as private moments, instead, the social sharing of this experience, here, emerges as a key trigger (and not just effect or correlate) for these phenomena. At the physiological level, lower respiration rate has been

found to be positively correlated to a higher level of mindfulness (Ahani et al., 2014), while on the contrary, STEs have been found to induce an increase in alpha and theta EEG power (Cahn and Polich, 2006).

Self-transcendent experiences could be placed on a continuum, as they encompass a collection of phenomena ranging from mindfulness, flow, and ST emotions to TEs of awe, peak experiences, and MEs (Yaden et al., 2017).

First, as core transformative elements of a STE, it would be possible to identify special emotional states deemed as complex and transformative (Chirico and Gaggioli, 2021b; Chirico et al., 2021c), such as the emotion of awe (Chirico and Yaden, 2018c; Clewis et al., 2022). These specific emotions encompass the two main dimensions of STE, that is, connectedness and the small self. Moreover, they can be elicited by a variety of inductors, including specific VR simulations (Chirico et al., 2021a). At the physiological level, for example, awe results as a mixed-valenced emotional state, as captured by electromyographic measures (EMGs) and testified by a concurrent activation of the parasympathetic nervous system and withdrawal of the sympathetic one (Chirico et al., 2017). Positive awe has been positively related to the central alpha and the beta band. It also showed negative correlations with the gamma band (Hu et al., 2017). After an experience of awe, indeed, individuals have shown more prosocial attitudes and behaviors toward other people and nature, as well as decreased aggressivity, increased generosity (Piff et al., 2015; Stellar et al., 2018), enhanced creative thinking abilities (Chirico et al., 2018b), and decreases in the cognitive emotion regulation strategy of rumination (Lopes et al., 2020). At the same time, when the awe experience is negatively connotated, it has been associated with the feeling of fear and powerlessness, loss of self-control, uncertainty, and lowered sense of situational control (Piff et al., 2015; Stellar et al., 2017).

Secondly, peak experiences can be seen as prototypical transformative examples of STEs (Maslow, 1964) consisting in a moment of elevated inspiration and enhanced well-being that can permanently influence individuals' attitudes toward life and that can occur in all cultures (Maslow, 1962). Several characteristics are associated with peak experiences, including the perception that the world is good, beautiful, and desirable. Additional features are mainly emotional, such as feelings of being lucky, fortunate, or graced. Other features are more related to space and time dimensions, describing usual disorientation and strain for both. Peak experiences are also known for their short duration, although time perception could be expanded. They can be observed during a learning process (Lanier et al., 1996), during peak performance, sports activities (Privette, 1983), and within the musical domain (Gabrielsson et al., 2016). They can be triggered in various contexts, also in response to psychological turmoil (Taylor, 2012), and nature exposure (Naor and Mayseless, 2020). Among frequent aftereffects, there are heightened feelings of happiness, joy, and ecstasy, as well as fulfillment, peak performance; and, generally, psychological effects are seen as dependent on the context of emergence of peak experiences (Lanier et al., 1996; Solberg and Dibben, 2019).

Finally, MEs can also occur during structured spiritual or religious practices or even unintentionally (Barrett and Griffiths, 2017). These phenomena have been deemed as a particularly intense variety of self-transcendent TEs (Yaden et al., 2017) that hinge on a sense of reality far from ordinary experiences and that are characterized by feelings of unity with the whole reality (Cardeña et al., 2017). Initial characterizations of MEs suggested –

within the variety of MEs – either a mysticism of introspection or of unifying vision (Otto, 1932). Indeed, MEs alter some key aspects of consciousness, such as the sense of time and space (Hood, 1975; James, 1902; Newberg and d'Aquili, 2008; MacLean et al., 2012). In addition, if they are induced by psilocybin, they also encompass the dimensions of sacredness and positive moods (MacLean et al., 2012). For instance, Stace (1960) stated that an ultimate unity "is the very essence of all mystical experiences" (p. 132), which can be further detailed as introvertive (characterized by a pure consciousness overcoming the boundaries of space and time) vs. extrovertive (featuring an "inner subjectivity of life in all things"; Stace, 1960, p. 131). These two types of MEs also share a sense of objectivity, peace, sense of sacredness, paradoxicality, and supposed ineffability (Wulff, 2014). At the emotional level, MEs entail mixed feelings ranging from fear to intense positive feelings (van der Tempel and Moodley, 2020). At the phenomenological level, these experiences have been described as brief, ineffable, and overwhelming (Yaden et al., 2017). James (1902) particularly highlighted that MEs possess ineffability and noetic quality (i.e., they reveal an otherwise hidden or inaccessible knowledge), and, sometimes, a sense of passivity and transiency. Other authors stated that MEs entail the perception that the self is perfectly integrating with one's surroundings (James, 1902; Stace, 1960; Newberg and d'Aquili, 2000; Hood, 2002). Overall, MEs are associated to positive psychological outcomes, such as an enhanced sense of connectedness, meaning in life, positive affect (e.g., more compassion toward self and the others), or a deeper sense of identity (Brett, 2010; Nixon, 2012; Garcia-Romeu et al., 2015; Chirico et al., 2022).

When MEs are spontaneous they can maximally challenge an individual's worldview, sometimes triggering emotional distress, confusion, and increased severity of previous psychological problems (for an overview, see van der Tempel and Moodley, 2020). When MEs are induced, they tend to reinforce previous religious schemas (Pargament et al., 2005).

Crucially, MEs can emerge in different ways, such as during sacred ritual, aesthetic experiences, physical illness, and meditation. Recently, Evans and Lynn (2021), showed that even a brief 5-min hypnosis induction could foster MEs in the lab. Longer hypnotic inductions can result in high levels of MEs in the lab (from a moderate to a great degree) in one-third of participants, as a function of their hypnotic suggestibility. MEs can be occasioned also by the psychedelic substance psilocybin in laboratory settings (for an overview, see Johnson et al., 2019), resulting in experiences comparable to those occurring in other settings both deliberately facilitated and occurring apparently spontaneously (Hood, 2014; Yaden et al., 2017b). At the neural level, the disintegration of different brain networks has been associated to a sense of dissolved self and altered salience processing (Carhart-Harris et al., 2016; Wahbeh et al., 2018).

1.2.4.3 Exceptional Bodily Experiences

The role of the body represents a crucial aspect that has not emerged before from the analysis of TEs provided within each discipline. Specifically, there is a class of TEs in which the body acquires a central role. It is the case of exceptional bodily experiences, in which the transformation is canalized and expressed through the body. This class of TEs can include: (1) kundalini awakenings; (2) NDEs; (3) OBEs.

In Hinduism, Kundalini awakenings reflect the release of inner energies through various forms, accompanied by several specific physical phenomena, such as feelings of energy in the hands, deep ecstatic sensations, and awareness of energy currents flowing through the body (Taylor, 2015; Woollacott et al., 2020) from the base of the spine (Greyson, 1993). These physical sensations are associated with a sense of joy and deep interconnectedness with others (Grey, 1985; Ring and Agar, 1986; Ossoff, 1993; Kason and Degler, 1996; De Lubac, 1999; Kason, 2019). The energetic awakening involves feelings of expansion and a dissociative and conscious awareness of leaving the body, and a sense of being enveloped in light or love (Woollacott et al., 2020). It can range from mild to intense feelings of joy to dramatic states (Taylor, 2017). As a result, kundalini awakenings entail long-term transformations in beliefs and values, including an increase in love for family, the desire to serve others, a belief in spiritual immortality, as well as deeper spiritual insights (Woollacott et al., 2020). According to western researchers, kundalini awakenings can occur in several circumstances, either spontaneously or induced (e.g., meditation, psychological turmoil, psychedelics), and they show a certain degree of overlap with NDEs (Ring, 1984; Greyson, 1993, 2000; Sanches and Daniels, 2008; Taylor, 2012).

In NDEs, – an acronym coined by Dr. Raymond Moody (1975) – the body is a key element (Holden et al., 2009). This non-ordinary state of consciousness emerges in response to a real or perceived proximity to death and entails – among other phenomenological correlates (Greyson, 1983) – the perception of leaving the body boundaries, traveling through a tunnel, and of being in front of an irreversible threshold (Martial et al., 2020). Individuals who survive them share a transformative sense of cosmic unity, transcendence of time and space, deep positive mood, sense of sacredness, noetic quality of intuitive illumination, paradoxicality, ineffability, transiency, and persistent positive aftereffects (Noyes and Slime, 1979; Greyson, 2006). NDEs' transformations are deep and long-lasting, with permanent and usually positive results (Morse, 1994; Simpson, 2001). For a comprehensive overview of NDEs, see Greyson (2015).

Although NDEs share many similarities with OBEs – and actually, may include OBEs (Blanke and Arzy, 2005; Blanke et al., 2016), they are quite different. Their major point of difference is that OBEs, conversely to NDEs, are not necessarily perceived as a threat to one's life, conversely to NDEs (Nelson et al., 2006). OBEs are states during which the self appears to occupy a position spatially apart from the experiencer's body (elevated extracorporeal location) (Blanke et al., 2016), involving both visual and somesthetic perception in which one's own physical body is illusory (Smith and Messier, 2014). OBEs' transformative impact on an individual's psychological well-being has been recognized (Riva et al., 2016), followed by an increasing interest in their healing potential (Sellers, 2019). OBEs and NDEs are similar both for their transformative outcomes and their nature, as they involve a dissociation from the body and hyper-real sensorial, perceptual, cognitive as well as affective processes (Blanke et al., 2016). NDEs are even less common than OBEs, with OBEs generally occurring rarely in lifetime (no more than once or twice) (Blanke et al., 2016).

Kundalini awakenings, NDEs, and OBEs can be considered three different manifestations of a sudden transformation unfolding through the body. However, the elicitors (or triggers) most frequently associated to these kinds of TEs are different. For example, elicitors could be traumatic events for NDEs (Greyson, 2000), e.g., cardiac arrest (Van Lommel et al., 2001), and meditation for kundalini awakenings (Woollacott et al.,

2020). Crucially, OBEs can be caused, besides specific pathological conditions (e.g., depression, personality disorders), pharmacological substance consumption (e.g., LSD, marijuana, etc.), stimulation of specific brain areas (i.e., the temporoparietal junction, TPJ; Bos et al., 2016) or general anesthesia, also by the simulation of multisensory conflicts between a visual stimulus and a tactile, vestibular, or cardiac stimulus induced in a VR setting, by means of videos or robotic devices (Blanke, 2012; Fernandez-Alvarez et al., 2021).

1.2.4.4 Psychedelically Induced Experiences or Psychedelic-Like Experiences

Increased attention has been given to psychedelics-induced experiences (Fadiman and Kornfeld, 2013), specifically, with regard to peculiar chemical triggers of TEs: psilocybin administration provided one of the first models for experimentally controlled investigation of quantum changes (Barrett and Griffiths, 2017). Under supportive conditions, psilocybin can foster deeply meaningful and significant experiences (e.g., mystical-type experiences, which are discussed later in detail) (Pahnke, 1963; Griffiths et al., 2006, 2011). Follow-up studies at 2 and 14 months confirmed that psilocybin experiences enabled participants to change durably and positively their attitudes and behaviors, and consistently with what community observers stated (Griffiths et al., 2006, 2008). Attributions to the psilocybin experience included changes in attitudes, mood, altruism, and other behaviors, as well as interpersonal closeness, gratitude, life meaning/purpose, forgiveness, death transcendence, daily spiritual experiences, religious faith, and coping (Griffiths et al., 2018).

Ibogaine was also found to have similar transformative effects too (Brown et al., 2019). Observational studies have described participants' increased reflection, forgiveness, and self-forgiveness (Brown et al., 2019), which allowed them to enhance empathy and to attain relief from guilt (Heink et al., 2017), thus enabling personal transformation. Also quantitative results (Brown et al., 2019) sustained ibogaine's psychotropic effects as being psychologically profound, leading to far reaching transformations (pp. 3–4), which is consistent with numerous other studies exploring ibogaine (Naranjo, 1969, 1974; Lotsof and Alexander, 2001; Schenberg et al., 2014; Heink et al., 2017; Camlin et al., 2018; Rodger, 2018) and other hallucinogens' effects, such as DMT, LSD, as well as mescaline (Hood, 1975; Griffiths et al., 2008; MacLean et al., 2011). For an up-to-date review of long-term effects associated to psychedelic drugs consumption, see Aday et al. (2020).

Crucially, it has been showed that it was possible to experience drug-like effects without consuming a drug but just by being close to someone who did so (Tart, 1971). Indeed, the effects of psychedelics originated also from contextual factors, including previous expectations. In a recent single-blind between-subjects study (Olson et al., 2020), some participants, belonging to the placebo group, reported intense alterations in consciousness, which had been usually found associated with moderate or high doses of psychedelics.

These controlled drug experiences, similar to mystical ones, incorporated the dimensions of unity, sacredness, positive mood, transcendence of time/space, ineffability (MacLean et al., 2012), and of being overwhelming both cognitively and emotionally. Like MEs, these states could be emotionally ambivalent, as they could involve not only positive emotions but also regret, fear, anxiety, and upset (Brown et al., 2019).

Specifically, at the phenomenological level, several authors have also tried to outline the unique experiential profile of psychedelic experiences (e.g., Preller and Vollenweider, 2016), and this phenomenon has been conceived as a dynamic process lying on a perception–hallucination continuum, which is characterized by an increasing arousal and by the loosing of ego boundaries (Preller and Vollenweider, 2016).

1.2.4.5 An Interdisciplinary Integrated Picture of Transformative Experiences: What is Shared and What is Different

The initial comprehensive analysis conducted so far by giving voice to all the acknowledged interdisciplinary varieties of TE provides a foundation for a new integrated picture of these phenomena. Hereinafter, first, we focus on the redundant characteristics that frequently have emerged within different domains and disciplines' discourse by applying the reasoning by analogy approach (Ketokivi et al., 2017). We provide an overview of the outcomes of this analysis in Table 1. Then, shared elements (at any levels, from the biological to the existential one) and distinctive features of each TE are discussed.

Table 1: Overview TEs instances' main features: main reference discipline(s), domain(s), phenomenological correlates, elicitors, and aftereffects.

TE Instance	Main Involved Discipline(s)	Domain	Main Reference(s)	Description	Epistemic Expansion	Emotional Complexity	Elicitors/Facilitating Conditions	Aftereffects
Religious conversion	Psychology, philosophy, anthropology, sociology	Religion, spirituality	James, 1902; Ullman, 2013; Snook et al., 2019	A moment of enlightenment, self-surrendering, and union with a new religious awareness of superiority consisting in a process through which persons move from their previously held religious beliefs to the beliefs of a new religious tradition.	Perception of new truths that were inaccessible before; time perceived as stopped, slowed down, or dilated; brief duration.	Sudden loss of all concerns, relief, sense of peace, harmony, deep happiness, faith. High emotional intensity.	Current theories: key active role of the convert, lower impact of external supernatural causes, more emphasis on converts' need for meaning and purpose, despite also cultural factors play a role.	Key personality changes (e.g., increase in honesty-humility, conscientiousness, and neuroticism after the conversion); key identity changes; new language; new beliefs.

Peak experience	Psychology, neurobiology, nursing, psychiatry, design, human computer interaction	Miscellaneous	Garcia-Romeu, 2010; Yaden et al., 2016a, 2017; Kitson et al., 2020	The transient mental state marked by the transcendence from the material and physical limitations, and by a deep connection with something greater than oneself.	A sudden and unexpected acceleration of personal development or self-actualization.	Perception of self-diminishment and decreased self-salience; time is perceived as unbounded.	Meditation, peculiar social events hinging on connection with others, virtual reality paradoxical scenarios, nature; catalyzed with spiritual instruction, dance, prayer, and psychedelic substances. Exposure to nature, sport, music, spiritual and religious context, learning.	Decreased anxiety, increased energy, insight, social ability, and sustained positive affect, value re-orientation, increased concern for others, increased positive affect, and disidentification from old patterns of thinking or behavior; increased prosociality (toward other people and nature); increased generosity, enhanced creative thinking; decreased ruminative strategies. The negative counterpart of ST emotions emerged as associated to highly intense fear and powerlessness, loss of self-control, uncertainty, and lowed sense of situational control.
Mystical experience	Philosophy, psychology, neurobiology	Religious, spiritual	James, 1902; Stace, 1960; Newberg and d'Aquili, 2000, 2008; Hood, 2002	Particularly intense variety of self-transcendent experiences (Yaden et al., 2017). An experience that tends to occur suddenly, it is often transient, it appears as ineffable, joyful, it involves the perception of an ultimate unity, of oneness; transcendence of the ego; a full conviction of immortality; and it tends to be attributed supreme value. Some people interpret MEs as experiences of unity with God (Thalbourne, 2003).	Perception of vanishment of the whole self, cognitively overwhelming, ineffable, noetic quality, sacredness; strain in space and mostly in time while it has a short duration.	Mixed feelings raging from fear to intense positive affect.	Psychedelics; hypnosis; meditation; sacred ritual, aesthetic experiences physical illness. Meditation, psychological turmoil, psychedelics.	Enhanced sense of connectedness, meaning in life, positive affect (e.g., more compassion toward self and the others) or a deeper sense of identity. Change in beliefs and values, reduced tendency to aggression; possible negative cognitive outcomes that leave an indelible mark, as disruptions of psychological functioning and mental illness; new sense of identity.
Kundalini awakening	Psychology, anthropology, sociology	Spirituality, self-transcendence	Taylor, 2015; Kason, 2019; Woollacott et al., 2020	Exceptional physical experience consisting of a huge release of energy, accompanied by temporary corporeal symptoms.	Conscious awareness of leaving the body, increased sensory sensitivity, deep interconnection with others; time is perceived as loosened, as the sense of linear time was lost (i.e., "out of time" experience).	Deep ecstatic sensations, joy, enhanced sense of connectedness and unity, reduced fear of death, feelings of expansion, envelopment in love or light; possible dramatic negative emotions.	Meditation, psychological turmoil, psychedelics.	Enhanced sense of connectedness, meaning in life, positive affect (e.g., more compassion toward self and the others) or a deeper sense of identity. Change in beliefs and values, reduced tendency to aggression; possible negative cognitive outcomes that leave an indelible mark, as disruptions of psychological functioning and mental illness; new sense of identity.

Near-death experience	Psychology, philosophy, neurobiology	Miscellaneous	Greyson, 2000, 2006, 2015; Simpson, 2001; Holden et al., 2009	Altered state of consciousness on the (real or perceived) threshold of death. Major focus on the peculiar feeling of leaving the physical body and encountering non-physical entities/environments.	Accelerated thoughts; life review; perception of understanding everything, flash from the past, perception of leaving the body boundaries, and of traveling through a tunnel and of being in front of an irreversible threshold; absence of time and space.	Sense of cosmic unity and sacredness, peace, positive mood, feelings of harmony, unity, joy, revelation, and connectedness.	Meditation, psychological turmoil, psychedelics; alternations in oxygen levels; neurological alterations.	New responses to life-threatening dangers, life review, sense of being controlled by an outside force, transformation of attitudes, shift to a new belief system, decreased death anxiety, heightened spiritual awareness.
Out-of-body experience	Psychology, philosophy, neurobiology	Miscellaneous	De Foe et al., 2012; Smith and Messier, 2014; Sellers, 2019	States during which the self appears to occupy a position spatially apart from the experiencer's body (elevated extracorporeal location) (Blanke et al., 2016).	Disembodiment: the self appears occupy an elevated extracorporeal location; enhanced reality, hyper-real cognitive perception, extremely vivid stimuli, and settings, intensified sensory inputs that lead to transformative outcomes.	Highly intensified emotions, hyper-real affectivity.	Pathological conditions (e.g., depression, personality disorders), pharmacological substances assumption (e.g., LSD, marijuana, etc.); stimulation of specific brain areas (temporoparietal junction area, TPJ); general anesthesia, also by the simulation of multisensory conflicts between a visual stimulus and a tactile, vestibular, or cardiac stimulus induced in virtual reality (VR), by means of videos or robotic devices.	Changes in bodily self-consciousness (self-identification and self-location); decreased fear of death; dissociation.
Trauma	Psychology, philosophy, clinical medicine, neurobiology	Clinical	Calhoun and Tedeschi, 1995, 2006; Tedeschi, 1999; Grof, 2000	Radical changes given by the experiencing of a negative high-impacting event. If changes are negative, the TE leads to trauma. If changes are positive, the TE turns into posttraumatic growth.	Expectancy, probability, and controllability evaluations associated to the events; sense of time distorted and bodily distortion as predictors of PTSD.	Terror, perception of threat.	Negatively overwhelming psychological stressors individuals could not cope with.	Altered self-capacities, mood disturbance, enhanced avoidance responses, posttraumatic stress.

Posttraumatic growth	Psychology, philosophy, clinical medicine, neurobiology	Clinical	Calhoun and Tedeschi, 1995, 2006; Tedeschi, 1999; Grof, 2000	Positive change experienced as a result of the struggle with traumatic events.	Expectancy, probability, and controllability evaluations associated to the events; sense of time can be distorted.	Terror, perception of threat; relief.	Negatively overwhelming psychological stressors individuals could cope with; the perception of the triggering event depends also on individual differences, e.g., the degree of previous religiosity.	Personal development, enhanced authenticity responsibility toward oneself and others, accepting attitude to death, increased self-confidence, new identity, values, and perspectives.
Post-ecstatic growth	Psychology	Miscellaneous	Fredrickson, 2004; Roepke, 2013; Mangelsdorf and Eid, 2015	Radical positive changes given by the experience of highly impacting positive events.	The relevance of time and space varies according to the ecstatic or peak experience, which generally involves a transcendence of these dimensions.	High positive emotional valence, which can be associable to the peak experience's one.	Positive affective experiences, awe moments.	Durable and positive changes regarding appreciation of life, relationships, enhanced spirituality, renewed life meaning, and personal strengths.
Psychedelic experience	Psychology, psychopharmacology, neurobiology, anthropology	Miscellaneous	Barrett and Griffiths, 2017; Camlin et al., 2018; Griffiths et al., 2018; Brown et al., 2019; Brouwer and Carhart-Harris, 2020	Dynamic process lying on a perception–hallucination continuum, which is characterized by an increasing arousal and by the loosing of ego boundaries.	Space and time transcendence; ineffability; overwhelming in nature; unity, ego-dissolution; perceptual illusions (alterations of the environment and of the body image; peculiar visual phenomena); deep insights into the nature and structure of the universe.	Gratitude, forgiveness, unity, death transcendence sacredness, positive mood, but also regret, fear, anxiety, and upset.	Typically elicited by psychedelic substances (e.g., psilocybin; Ibogaine; DMT; LSD).	Positive changes in attitudes and behaviors, increased positive coping, prosociality, and empathy. Negative long-term changes at the neurological, personality, molecular, and psychological level (see Aday et al., 2020).
Transformative learning experience	Education, psychology, philosophy	Learning	Mezirow, 1978 1997; Kleiber et al., 2002; Stone, 2014	Process of changing accustomed assumptions, thus producing an effective shift of reference frameworks.	Deep and structural shift in mental schemas, beliefs, and perspective, loss of old meaning perspectives tofind new selves, heightened self-reflection	Emotional and social learning, hope, newness, intense emotions as drivers for self-reflection,but also guilt, shame, disorientation,dissonance	Disorienting dilemma	Both positive and negative outcomes,e.g., changes in worldview, schema and paradigm, changes concerning how learners conceptualize themselves, and how they related to others or to the world in general; increased empowerment/responsibility; new ways of knowing, which is more open, discriminating, extrarational. Development of new skills. Implementation of new social actions,which are consistent with epistemological changes; heightened spirituality.

1.2.5 Applying the Reasoning by Analogy Approach

As a first step, we focus on the shared aspects across different instances of TEs, at a higher level. To this end, we drew from a reasoning by analogy approach (Ketokivi et al., 2017). This methodological approach, which was proposed by Ketokivi et al. (2017), relies on the concept of analogy, whose value has been recognized across all the sciences. (Hesse, 1966), since it provides links between two or more different domains of knowledge (Gentner and Markman, 1997), exploiting their similarities regarding one specific phenomenon, in order to make inferences that connect them (Gentner and Namy, 1999; Ketokivi et al., 2017). Analogies have proven to be effective in enabling progress for both research and theory, especially in boundedly rational and resource-constrained contexts, since they allow researchers to focus and deepen only the relevant part of the phenomenon, abstracting out other parts, and overcoming discrepancies (March, 1994; Ketokivi et al., 2017). Here, this approach permits to combine knowledge from different domains on TEs, in order to elucidate their transversal functioning. Then, we move to consider how each TE fulfills the shared elements differently, thus bringing forth varieties of TE.

From the implementation of the reasoning by adopting analogy approach, four specific high-level shared elements emerged that can be used to frame the multifaceted nature of TEs. Firstly, these concern, first, TEs' phenomenological dimensions (i.e., characteristics subjectively perceived by individuals during TEs). These features can be further divided into: (1) epistemic expansion (new forms of knowledge of the self and of the world) and (2) emotional complexity, involving intense, mixed emotions, and emodiversity (Berrios, 2019). In addition to the phenomenological elements, two psychological elements can be identified: (3) facilitating conditions/elicitors, and (4) specific effects on the recipient (aftereffects).

The epistemic expansion component concerns new forms of knowledge about the self and the world. For instance, in STEs, a sense of self-diminishment and of being connected with all beings is a predominant result. Peak experiences entail the appraisal of the world as a good, beautiful, desirable, place, and the awareness that all polarities and dichotomies have been resolved. In NDEs, there is a dissolution of body boundaries, perception of being able to suddenly understand everything, and being on the edge of an irreversible threshold. Moreover, subjective time perception is recurrently expanded or dilated, while the experience itself could last even a few moments. Space perception is also often strained, distorted, and transcended, as in the case of OBEs and NDEs. This dimension of altered time perception, instead, was less relevant (if not absent) in Mezirow's transformative learning process. However, during transformative learning, the disorienting dilemma acted as a central moment of belief shift through the violation of previous expectancies. Finally, Brouwer and Carhart-Harris (2020) model on PiMSs could provide a particularly suitable framework to address the neurobiological underpinnings of this epistemic expansion component, which reflects the phenomenological transversal dimensions shared by all the types of TEs considered so far.

The emotional complexity component deals with the extremely intense and mixed nature of feelings, affects, and discrete emotions involved during ongoing TEs. Extremely intense feelings can be found during traumatic events, OBEs, NDEs, or STEs. Emotional complexity mainly refers to the experiencing of positive and negative states together (i.e., emotional dialecticism) (Larsen et al., 2001; Spencer-Rodgers et al., 2010) and to the experiencing of emotions with high granularity, with a wider variety of discrete emotions reported (i.e., emotional differentiation) (Kashdan et al., 2015). Although the literature has often evidenced generally positive emotional characteristics of TEs, a deeper overview of these experiences showed that they are characterized by mixed emotions – involving the co-activation of opposite emotions at the same time – or by emotional variability (Larsen et al., 2001; Berrios, 2019). There could be two main mechanisms in which mixed emotions underlying TEs could work to give rise to these experiences. According to the bipolar view (Russell, 2017), mixed emotions may be felt when individuals have already undergone a transformation, but they still emotionally fluctuate between rejection and acceptance of a chosen behavior. Conversely, the bivariate view by Larsen (2017) suggests that an event could be characterized by two simultaneous opposite feelings (e.g., fear and happiness at the same time) (Roseman, 2017). People living a TE are likely to experience a diverse and abundant array of emotions, ranging from ecstasy, bliss, and relief (e.g., as in religious conversions) to guilt, fear, and regret (see psychedelic-induced MEs in Brown et al., 2019). The breadth of TEs' emotional repertoire can suggest that these experiences are characterized by emodiversity, which refers to the richness of emotional complexity (Quoidbach et al., 2014; Berrios, 2019).

Finally, TEs can usually be conceived as either spontaneous events or as induced by specific facilitating conditions, also by recognizable elicitors. Facilitating conditions/elicitors for each TE analyzed in this work are reported in Table 1.

Some specific state-conditions act as recurrent triggers of different TEs (psychedelics, meditation, spiritual practices), others as peculiar elicitors of specific instances of TEs (e.g., cardiac arrest for NDEs) (for a finer and up-to-date list of triggers, see White and Brown, 2000). In addition, recently, more stable variables (trait-like) have emerged as potential preparatory conditions for engendering specific TEs, as in the case of PTG, which is facilitated by previous religiosity (i.e., religious affiliation and strength of religious beliefs) (Taku and Cann, 2014). Crucially, novel technological devices, such as VR, have been proposed as valid tools for inviting even more complex TEs in the lab (see OBEs in Bourdin et al., 2017; van Heugten-van der Kloet et al., 2018). VR, indeed, allows manipulating (also separately) several components of cognition and emotion (Slater et al., 2010; Slater, 2018; Bolt et al., 2021) as well as overall potentially TEs (Chirico et al., 2020).

However, if basic underpinnings of TEs are not previously captured and understood, VR can turn useless. Indeed, there is always a risk of mistaking the role of this tool in promoting this class of experiences by nurturing fallacious reasoning. It should be noted that VR can easily resemble phenomenological features typical of a given TE. However, this would not guarantee that the same underlying mechanisms/underpinnings of a TE are activated during an equivalent VR experience. Therefore, a deeper comprehension of the basic mechanisms underlying each TE (starting from their facilitating conditions) is essential to reproduce it in the lab by means of VR or any other simulation tool.

Finally, although it may look redundant, it would be useful to demonstrate that all the experiences included in this conceptual analysis show specific effects on the recipient (aftereffects) that would be able to impact individuals' cognition, emotions, and personality in the long run. This has always been a basic criterion used to define TEs, as mentioned at the beginning of the present work. However, even though all instances of TEs considered so far entail long-lasting, pervasive aftereffects, they also feature a high degree of variability in terms of their consequences. This, again, could support the idea that – echoing William James's seminal work on religious experience – it would be useful and appropriate to indicate TEs as "varieties of transformative experience" with two shared core components, elicitors/facilitating conditions particular to specific types of TEs, along with a certain degree of internal differentiation.

These components were summarized in Table 1.

1.2.6 Toward a Tentative Integrated Interdisciplinary Conceptualization of Transformative Experience

In line with all the evidence reviewed and analyzed so far, a new preliminary integrated definition of TEs is here advanced.

Transformative experiences can be defined as brief experiences, perceived as extraordinary and unique, entailing durable and/or irreversible outcomes, which contribute to changing individuals' self-conception, worldviews, and view of others, as well as their own personality and identity by involving an epistemic expansion (as new forms of knowledge of the self, others, and the world) and a heightened emotional complexity (emotional variability, high intensity, mixed emotions), as the two core phenomenological features. They are usually remembered vividly.

These experiences emerge suddenly, either apparently spontaneously or they can be invited by specific elicitors/facilitating conditions encompassing both state (related to contingencies) and trait elements (related to more stable conditions of the experiencer). Elicitors, usually, are perceived as novel stimuli, able to challenge an individual's mental schema, thus also resulting in disruption.

Some TEs can also encompass transcendental elements. Some TEs (and some phases of a TE) can be marked by peculiar neuropsychophysiological underpinnings.

Finally, it is appropriate to conclude this section by suggesting that a more active dialog among several disciplines and domains would be not only be desirable but also especially advantageous, despite the effort that this would require.

1.2.7 Conclusion

Although literature on specific types of TEs is growing and bringing forth promising results, an integrated view of this phenomenon has yet to be developed. In this conceptual analysis, we aimed to provide this interdisciplinary view by marking shared phenomenological features of TEs, as well as their intrinsic particularities, to outline a preliminary interdisciplinary operational definition of TEs.

This effort could turn, as a first outcome, into a more fluid dialog among scholars from different disciplines interested in examining this phenomenon at different levels of analysis, thus resulting in a finer and more comprehensive view of the phenomenon and its underpinnings. Otherwise, the risk can be a fragmentation of TEs' conceptualization and research.

As a second outcome, this endeavor could lead to a paradigmatic shift, as the direction of research is moving from retrospective to predictive study of TEs. For instance, nowadays, it is only possible to sense pandemic as a potentially TE. An open issue is to scientifically predict the extent to which this will occur, that is, to measure its transformative potential. This would be possible only after having elucidated the underpinnings of transformation at different levels, from the biological to the existential level. In this regard, the results of this analysis could inform the design of novel, integrated, and comprehensive instruments to measure the potential of an event to engender a specific type of TE in a particular person. Moreover, future studies could also consider the possibility of developing a new comprehensive and interdisciplinary instrument capturing the "minimal transformation" embedded into an experience, also building upon the conditions for the appearance of a minimal phenomenal self (e.g., Windt, 2015b; Josipovic and Miskovic, 2020; Metzinger, 2020). This could be useful, for instance, in the assessment of health promotion interventions. Other possible research lines could elucidate and systematically analyze the antecedents/facilitating conditions giving forth different types of TEs, thus enriching the examination of these class of experiences. The aim of this work is to stimulate a fluid dialog among researchers to acquire a comprehensive view of this phenomenon, despite it should be noted that this work is preliminary in nature and needs to be constantly updated by new evidence, insights, and suggestions.

1.2.8 Author Contributions

AC and EG wrote the first draft. AC conceived the rational along with AG and MP. AK and BR revised the manuscript, provide relevant suggestions, and improvements. All authors contributed to the article and approved the submitted version.

1.3 Exploring a Subset of TEs: Systematic Review of Aesthetic Transformative Experiences

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1.3.1 Abstract

Background: Transformative experiences (TEs) have been conceptualized in many ways, contexts, magnitudes, and durations, but at their heart, they entail some manner of adjustment, which contributes to changing individuals' worldviews, actions, views of others and/or their own feelings, personality, and identity. Among the many elicitors identified as being able to foster TEs, an emerging body of literature has suggested that TEs might be prevalent in aesthetics or emerged from encounters with human art. Beyond denoting ordinary moments characterizing our daily lives, art and aesthetics could occasionally represent profound changes, causing shifts in our perceptions, beliefs and understanding of the world. However, in the realm of psychological inquiry, the extent to which art and aesthetics can be considered potential catalysts for transformation remains a topic of debate. Furthermore, a comprehensive identification of the key psychological components that contribute to the process of transformation before, during, and after aesthetic engagement is still missing.
Aims: This systematic review endeavors to address these gaps by synthesizing literature on aesthetic transformative experiences either from the field of psychology or explicitly delving into the psychological impact of transformative experiences within the realm of art and aesthetics. It encompasses both theoretical and empirical papers to determine key aspects and psychological components that characterize TEs.
Methods: Two major electronic databases were systematically searched. The review was conducted in accordance with Liberati et al. (2009) and PRISMA guidelines. All stages of the review were conducted independently by three researchers, and the protocol was published on PROSPERO (Registration no.: CRD42022298655).
Results: Although 39.440 studies were identified, only 23 peer-reviewed articles were included in this review, as most studies did not explicitly delve into the long-lasting psychological impact of art and aesthetics.
Discussion: The results confirm the potential of art and aesthetics as elicitors of transformation regardless of the type of artwork and the usage context. Moreover, it also identifies some psychological components necessary for transformation in the realm of art and aesthetics, including facilitating conditions/pre-expectations, cognitive discrepancy, epiphany and insight, and several after-effects on the recipient.

Conclusions: The review aids in refining and enriching the concept of transformative experience, paving the way for further research and applications in various fields, including not only psychology but also education and therapeutic interventions.

1.3.2 Introduction

The concept of transformative experiences (TEs) has gained increasing attention across diverse domains and disciplines. This heightened interest has led to comprehensive exploration of these complex phenomena in various fields including education (Mezirow, 1997, 2018), anthropology (Van Gennep, 1908; Turner, 1974), technology (Gaggioli, 2016), philosophy (Paul, 2014), neurobiology (Kielhofer, 2011; Brouwer and Carhart-Harris, 2020) and religion (James, 1902; Stronge et al., 2021).

In the realm of psychology, empirical evidence has significantly contributed to the definition of TEs. These experiences have been deemed as extraordinary and unique events that bring about lasting and sometimes irreversible changes in individuals' self-conception, worldviews, relationships, personality, and identity (Miller & C'de Baca, 2001). The characteristics of these experiences, which can take the form of an epiphany or a sudden insight, are reported to be remarkably consistent across cultures (Gaggioli, 2016). However, they have also been found to affect individuals profoundly in different ways (Hayes et al., 2007) at different stages of life (Mezirow, 1997), and, most importantly, in response to different elicitors (Chirico et al., 2022; Gaggioli, 2016). Actually, TEs encompass religious conversions, self-transcendent, peak and mystical experiences, out-of-body and near-death experiences, and psychedelic journeys, as elucidated and organized in a recent conceptual analysis of TEs by Chirico et al. (2022).

Although all of these experiences, with their respective elicitors, of our engagements with the environment, the supernatural, or with each other, and the unique transformative potential that seems to be contained within them and our human psychology itself, are compelling in their own right. One particularly salient topic that has emerged in recent years involves transformations brought about by art and aesthetics (e.g., see Pelowski & Akiba, 2011; Pelowski et al., 2017; for earlier reviews on the theme, see Lasher et al., 1983; Carroll, 1988). That is, beyond an important aspect of more ordinary moments across our daily lives—of which they are certainly a key component (Saito, 2017)— emerging research has suggested that aesthetic experiences might transcend mere entertainment or sensory stimulation, profoundly affecting our perceptions, feelings, beliefs, and understanding of ourselves and the world around us (Leder et al., 2012; Pelowski & Akiba, 2011; Markovic, 2012; Pelowski et al., 2017). For instance, delving into an immersive book, which has the power to profoundly engage and captivate the reader, can be likened to a "portal" to alternate dimensions: it submerges us in narratives and immerses us in the inner lives of characters (Braun & Cupchik, 2001). The power of storytelling offers new perspectives, challenges preconceived notions and creates empathy for a wide range of human experiences (Meretoja & Davis, 2017). Dipping one's Madeleine into tea and taking a taste—to take the classic example from Proust (1981)—may flood us with memories, but also new realizations about the past of our own life and relationships (see e.g., Adorno, 1973). Similarly, visiting an art exhibition provides an opportunity to

encounter visually compelling and thought-provoking works, inviting us to question established beliefs and consider alternative viewpoints (Arnold et al., 2014). The contemplation of art stimulates our imagination, triggers reflection, and elicits complex emotional responses (Freedberg, 2013).

Philosophy, particularly the philosophy of art, has long been concerned with understanding how art fosters processes of transformation on both individual and collective levels. Art is not confined to the representation of reality; it functions as a significant agent of cognitive, emotional, and ethical change. As Dewey (1934) argued, aesthetic experience is an active and immersive process, wherein the observer engages with the artwork in a way that reconfigures their perception of reality. This interaction with art facilitates a form of experiential learning, enabling individuals to reassess their beliefs and values. Gadamer (1986) further developed this idea by suggesting that art serves as a medium through which truth is disclosed, involving the observer in a dialogical process. In this engagement, individuals are not passive recipients but active participants in the creation of meaning, which can lead to transformative experiences that deepen their understanding of historical and cultural contexts. This concept aligns with Gadamer's notion of "hermeneutic openness," where interpreting art becomes a pathway to personal and communal growth.

More contemporary philosophers, such as Shusterman (2000), have expanded on these ideas by exploring the pragmatic dimensions of aesthetic experience. Shusterman emphasizes how art can enhance both intellectual understanding and the quality of everyday life. His concept of "somaesthetics" highlights the embodied nature of aesthetic experience, arguing that the transformative potential of art is closely tied to the physical and sensory aspects of human experience.

In the realm of psychology, only in recent times, several contributions have undertaken empirical investigations into the transformative potential of aesthetic experiences (Pelowski & Akiba, 2011; Pelowski et al., 2017). Furthermore, outside the realm of psychology, an expanding body of research, spanning fields from education to design, has also started to explore the potential of art and aesthetics as elicitors driving personal and societal transformations.

Nevertheless, due to the varied and diverse nature of the psychological literature on art/aesthetics, questions persist about to what extent art and aesthetics can be categorized as elicitors of transformation. For example, there is still a lack of synthesis regarding the variety of artworks (including traditional forms and new media), usage contexts, and methods for evaluating and comparing the transformative potential of art and aesthetics. Moreover, there is currently a lack of a complete understanding of the psychological components that define aesthetic transformative experiences.

The subsequent analysis serves as a first endeavor to address these knowledge gaps and offer a comprehensible and relevant synopsis of the current body of literature pertaining to the transformative power of art. Our contribution is situated within the psychological literature on transformative experiences (TEs). Specifically, we aim to structure a discussion regarding the potential inclusion of art and aesthetics as elicitors of such TEs in order to establish a fundamental basis for subsequent empirical investigations, thereby enhancing our understanding of the transformative potential of aesthetic experiences.

1.3.3 Research questions

This systematic review explores the extent to which art and aesthetics can be considered elicitors of personal transformation regardless of the type of artwork, context, and methodological approach used to assess their transformative potential. Additionally, the review elucidates the key psychological components contributing to the transformative process during and after aesthetic experience.

To do this, the current work synthesizes all the existing contributions in the psychological literature on the topic as well as studies explicitly addressing the psychological components of TEs within the domain of art and aesthetics.

This systematic review is guided by two primary research questions:

RQ1: To what extent can art and aesthetics be classified as transformative elicitors, and how does this categorization vary across different types of artworks, usage contexts, and the methodological approaches employed to evaluate their transformative potential?

RQ2: What are the fundamental psychological components characterizing aesthetic transformative experiences?

To deepen our understanding of the concepts of "aesthetic experience" and "transformation" and to guide our study selection, we draw upon recent theoretical advancements in both areas.

Within the psychological literature, the concept of aesthetic experience is highly relevant yet often poorly specified. It is frequently referred to using various terms such as aesthetic “engagement” (Brinck, 2018; Williams et al., 2013), “encounter” (Csikszentmihalyi & Robinson, 1990), “appreciation” (Leder & Nadal, 2014), “perception” (Biaggio & Supplee, 1983) or "engagement” and "encounter" with art (Shim et al., 2019; Csikszentmihalyi & Robinson, 1990), together with "perception" and “appreciation” of art (Crozier & Chapman, 1984; Roald, 2008). These terms are commonly used to describe the process by which individuals interact with and respond to art and aesthetics. In this review, we also use these to denote the broader concept of aesthetic experience.

Also, we refer to the definition of aesthetic experience provided by Mastandrea et al. (2019) and Markovic (2012), which state that aesthetic experiences involve the appreciation of aesthetic objects, resulting in a particular kind of “pleasure”. This pleasure is distinct because it is not derived from the utilitarian properties of the objects but is intrinsically linked to their inherent aesthetic qualities. Thus, aesthetic experiences can emerge from the appreciation of human-made artifacts, such as artworks, including (but not limited to) poetry, sculpture, music, and visual arts. They can also arise from natural objects that possess aesthetic value, such as sunsets or mountain vistas (Mastandrea et al., 2019).

In this review, we focus on aesthetic experiences specifically associated with the appreciation of artworks, and we exclude those experiences that involve the production or creation of art.

With respect to the concept of transformation, according to Chirico et al. (2022), TEs are: "brief experiences perceived as extraordinary and unique, leading to enduring and potentially irreversible outcomes that change individuals' self-conception, worldviews, perceptions of others, as well as their personality and identity" (p. 14). Within this framework, two core components emerge: (1) epistemic expansion and (2) emotional complexity. Additionally, the authors identified two relevant psychological factors: *facilitating conditions* and *recipient aftereffects.* The former pertains to particular conditions, such as dispositional traits and contextual factors, which consistently serve as recurring triggers for various TEs. The latter category relates to specific aftereffects, which have the potential to influence individuals' cognition, emotions, and personality over an extended period. Their distinction has long been a fundamental criterion for defining TEs (Chirico et al., 2022).

In the context of aesthetics and art, as proposed by Pelowski & Akiba (2011) and in the more contemporary model of art perception outlined by Pelowski et al. (2017), transformation takes place when individuals perceive a misalignment between their pre-existing cognitive frameworks, expectations, or schemas, and the stimuli presented within artworks. Resolving this cognitive dissonance - often triggered by ambiguity or complexity in interpreting symbolic elements - leads to an "epiphany" – a sudden realization or insight. This profound understanding emerges as a result of the cognitive dissonance resolution provoked by the aesthetic encounter. Importantly, this cognitive dissonance comes along with significant affective responses. These emotional reactions play a crucial role in the transformative process, as the dissonance not only challenges cognitive structures but also evokes strong emotional experiences. These affective responses can range from initial confusion or frustration to feelings of e.g. satisfaction, joy, or even awe, upon resolving the dissonance.

The transformative process comprises four major stages and is influenced by five contextual factors. Each stage – pre-encounter, cognitive mastery, secondary control, meta-cognitive assessment, and immediate outcomes – corresponds to specific psychological factors, including physiological responses, cognitive activity, and affective states.

In summary, Chirico et al.'s (2022) conceptual analysis underscores two fundamental psychological components inherent to TEs: facilitating conditions and aftereffects, which encompass the enduring influence of the experience on the individual. Furthermore, we have incorporated insights from the theoretical models put forth by Pelowski & Akiba (2011) and Pelowski et al. (2017) to identify supplementary psychological factors linked to cognitive, emotional, and physiological responses to experiences categorized as transformative, as well as the ultimate outcomes of these experiences. The two models have been included together as they offer distinct yet complementary contributions. While the former establishes the foundation for empirical analyses of transformative experience in a cross-disciplinary and cross-domain context, the latter focuses specifically on the domain of aesthetics.

1.3.4 Methods

1.3.4.1 Protocol and registration

This systematic review was registered on the pre-registration platform PROSPERO # CRD42022298655. To conduct this systematic review, we followed guidelines proposed by Liberati et al. (2009). This involved five steps:

a) initial identification of objectives and goals of the study;
b) a systematic search, in compliance with the eligibility criteria previously identified;
c) an assessment of the validity of the findings (here we used the Downs and Black 26-item QAT scale developed by Downs and Black, 1998);
d) a systematic synthesis of the findings;
e) a final discussion of the findings.

1.3.4.2 Identifying relevant studies

A systematic search of the literature was performed in two academic databases: PubMed and Scopus. Google Scholar was also used as an additional academic search engine to ensure that the maximum number of relevant psychological contributions were retrieved. The search was focused on aesthetic experiences with the aim of being transformative, according to the definition and factors identified by the most recent integrated interdisciplinary conceptualization on TEs proposed by Chirico et al. (2022) and recent models describing aesthetic transformative experiences (Pelowski & Akiba, 2011; Pelowski et al., 2017).
We sought articles from any time until August 2023, the end of this search. We utilized the retrieval of relevant articles with the following search terms:

("Aesthetic experience*" OR "Aesthetic engagement" OR "Aesthetic perception" OR "Aesthetic appreciation" OR "Consuming art" OR "Producing art" OR "Art*" OR "Aesthetic*" OR "Artistic product*" OR "Aesthetic product*") **AND** ("Transformation" OR "Transformative" OR "Change" OR "Outcome*" OR "Emotion*" OR "Cognition" OR "Emotional response* OR "Cognitive response*" OR "Physiological response*").

The first part of the search index concerns terms and words related to the experience of art and the fruition of aesthetic stimuli. The second part includes terms and words related to the dimension of transformation in terms of a long-lasting impact. This search string was applied to the title, abstract, full-text, and author keywords. Google Scholar was used for backward reference searching to run general searches of specific references and to identify relevant articles.

1.3.4.3 Study selection

Peer-reviewed articles – original studies as well as theoretical papers or reviews - with the following characteristics, published from the beginning of the literature until August 2023, were included:

- written in English or translated into English;
- dealing with stimuli classified by the authors as "art" or, more generally, involving aesthetic experiences;
- published in the psychological domain and/or explicitly addressing the transformative side of said experiences in terms of a detectable psychological impact, according to the definition given, and psychological factors identified by the recent conceptual analysis by Chirico et al. (2022) and models accounting for transformation in the realm of art and aesthetics (Pelowski & Akiba, 2011, Pelowski et al., 2017).

Blog entries and websites - even though they may offer valuable insights and be maintained by reputable scholarly organizations - were omitted from consideration due to the challenges associated with comparing them to other types of literature.

The selection of our inclusion criteria for this systematic review requires two fundamental considerations.

First, in pursuit of a comprehensive analysis of TEs within the realm of art and aesthetics, we opted not to restrict our selection solely to studies within the psychological literature. This choice was made because numerous studies outside the psychological field explicitly address and provide in-depth and quantifiable insights into the psychological impact of transformative aesthetic experiences.

Secondly, we aimed to encompass both review articles, such as literature reviews, systematic reviews, and meta-analyses, as well as empirical research articles. We deliberately included theoretical studies in our review due to their prevalence in discussions concerning the psychological effects of art and aesthetic experiences. Excluding theoretical papers would not have reflected the totality of current discussion and data on this entirety, and thus would have been potentially detrimental to the comprehensiveness of our analysis. These theoretical contributions significantly contribute to shaping our understanding and conceptualization of transformative aesthetic experiences, providing valuable insights and perspectives that complement empirical research.

Consequently, articles with the following characteristics were excluded:

- dealing with art and aesthetic experiences but not explicitly assessing their psychological impact in terms of durable and/or irreversible change;
- addressing transformative experiences but related to a different, unrelated (e.g., non-art/aesthetic) topic;
- involving clinical populations (i.e., participants affected by psychological, neurological, and/or cognitive disorders).

Excluding articles involving clinical populations allows us to focus specifically on studies related to aesthetic experiences in non-clinical contexts. By doing so, we aim to gain a clearer understanding of the transformative potential of art and aesthetics for the general population without the potential confounding effects introduced by clinical conditions. This approach helps maintain the scope of our review and ensures a more coherent analysis of the research pertinent to our research question.

The initial search elicited 38,440 articles from the two databases and 176 from the reference review, which were retrieved with Google Scholar. 3,239 duplicates were identified and removed, leaving 35,201 articles to be

screened. The initial screening of studies was based on their abstracts and titles, excluding noticeably irrelevant studies based on the inclusion/exclusion criteria priorly listed.

This large number of records was retrieved due to the wide initial search criteria that were adopted to avoid missing potentially relevant articles.

However, following our above refinement criteria, in total, 54 articles were identified as appropriate for inclusion, and moved to the second screening round. The second round of screening was based on the full text of the articles, and the first (M.P.) and fourth (S.B.) authors independently reviewed each using the inclusion/exclusion criteria set before the search, as suggested by Levac et al. (2010). The second author (M.P.) and third author (T.D.) adjudicated when there were disagreements about whether to include the data extracted. In total, 23 articles were identified as appropriate for inclusion and relevant to the current review. Out of these, 12 were theoretical in nature, with the remaining 11 being empirical studies. The authors reviewed all articles independently. All reviewers together conjointly shaped the categories and themes of the review based on the data extraction process. A PRISMA flow diagram that depicts the flow of information through the different phases of the articles and maps out the number of papers identified, included, and excluded, and the reason for exclusions is shown in Figure 1.

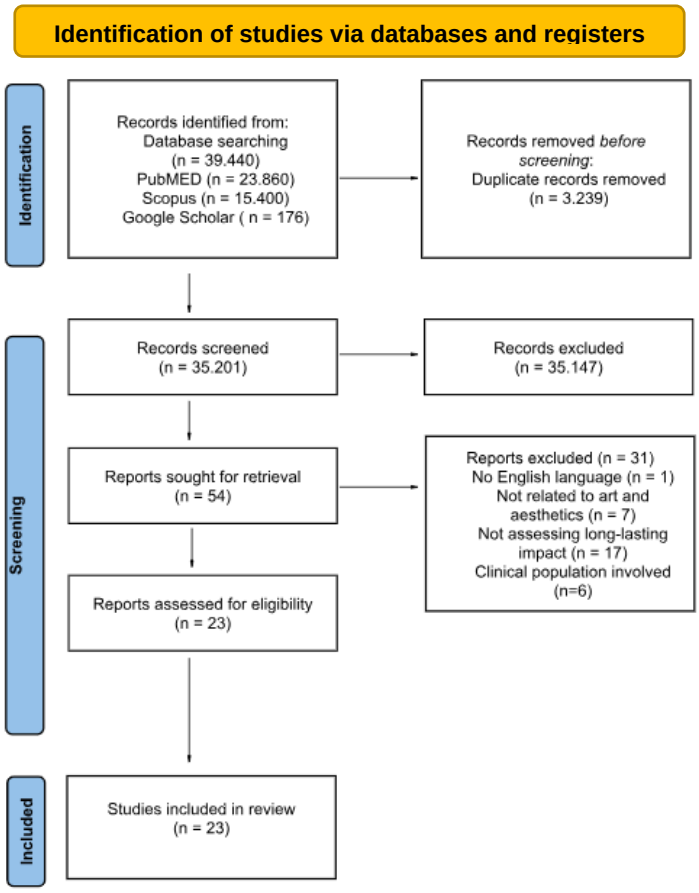

Figure 1: Flowchart of the included and excluded articles from the assessment of screening and eligibility process.

1.3.4.4 Risk of bias assessment

To assess the risk of bias and the overall methodological quality of the studies included in our analysis we employed the Downs and Black 26-item Quality Assessment Tool (QAT) scale (Downs & Black, 1998). Our decision to employ this rigorous assessment tool was influenced by its well-established validity and reliability within the domain of systematic reviews (Deeks et al., 2003). The scale offers a comprehensive evaluation of study quality on a 26-item checklist, encompassing aspects such as reporting, external quality, internal validity bias, and internal validity confounding. Each item is scored either 0 or 1, with one exception in which the score range of 0–2 is applicable, resulting in a maximum possible score of 27. Scores can be interpreted as "excellent" (24–28 points), "good" (19–23 points), "fair" (14–18 points), or "poor" (< 14 points), providing a standardized measure of study quality.

As the scale is primarily designed to evaluate the methodological rigor and quality of empirical studies – which is particularly relevant when assessing potential sources of bias in data collection, analysis, and reporting – we opted to utilize it exclusively for empirical research papers within our systematic review.

1.3.4.5 Data extraction

A spreadsheet software (i.e., Microsoft Excel) was used to collect and catalog the articles. A copy of the sheet was made available also on an open access software (i.e., Google Docs) (https://shorturl.at/cyUsm). All articles found by searching for the above keywords have been cataloged according to the following scheme:

- title;
- author(s) and year of publication;
- type of study;
- study design;
- number of participants;
- type of art/aesthetic experience;
- field/domain of application;
- methods/instruments;
- presence/absence of a control condition;
- facilitating conditions;
- physiological responses;
- affective responses;
- cognitive responses;
- final outcome;
- specific effects on the recipient (*aftereffects*).

1.3.4.6 Reporting the results

The findings of this systematic review are presented to address the two research questions.
To report the findings related to the first research question (RQ1), we have organized the studies by providing a comprehensive overview of both theoretical (e.g., study type) and empirical studies (e.g., participant count, study design). Additionally, we describe the types of art or aesthetic experiences considered and the various contexts in which they are applied. A summary table has been created to synthesize these findings, ensuring clarity and ease of reference (see Table 1a).
To address the results for the second research question (RQ2), which aims at identifying the psychological components contributing to TEs fostered by art and aesthetics, we rely on the definition and criteria for TEs as outlined in the recent analysis by Chirico et al. (2022) and on theoretical models on transformation within the realm of aesthetic encounters (Pelowski & Akiba, 2011; Pelowski et al., 2017). These criteria are broadly categorized into facilitating conditions, physiological responses, cognitive responses, affective responses, as well as related final outcomes and aftereffects and re. To avoid redundancy with the discussion part, we have included a detailed table presenting the principal findings related to RQ2 (see Table 1b). The comprehensive presentation of these findings is elaborated upon in the discussion section.
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1.3.5 Results

Out of the 23 articles identified during the systematic review process, 12 were of a theoretical nature, including reviews and theory articles, while the remaining 11 were empirical research articles. One of the original research articles encompassed three distinct studies, resulting in a total of 13 individual empirical studies documented.
Subsequently, we assessed the quality of these 13 empirical studies using the QAT scale (Downs & Black, 1998).
Upon analyzing the 13 transformative experiences investigated within these studies, we calculated an average overall quality index on the QAT scale of 16.16 (SD = 2.40), with scores ranging from 13 to 21 (highest possible QAT = 27). These scores indicate that the studies fall within the range of fair to good validity and reliability with only one study performing poor.

1.3.5.1 Description of included studies

Regarding the theoretical studies included in our systematic literature review, nine of them were literature reviews, two were hypothesis articles and one was a reflection article.
Empirical studies identified for this systematic review encompassed data from 51,789 participants in total, with sample sizes ranging from 5 to 50,797 participants. All included studies varied in terms of their study design. Studies included action research, a quasi-experimental design, mixed-methods, population-based designs, controlled before and after design and uncontrolled before and after design. Only two studies made comparisons with an active control group. The remaining studies did not utilize control groups.

1.3.5.2 Description of type of art/aesthetic experience

Both theoretical and empirical articles included in our systematic review encompassed a diverse range of art forms and aesthetic experiences. It's important to note that many studies included multiple types of aesthetic experiences within their analyses, allowing for a comprehensive exploration of the transformative potential across various art forms. They included:

- Visual Arts: The majority of the studies (83.3%) explored aesthetic experiences related to visual arts, such as paintings, sculptures, and art installations.
- Dance: Around one sixth (16.6%) delved into the transformative potential of dance performances, analyzing how movement and choreography influenced participants.
- Music: Around a third (33.3%) examined the power of music as an aesthetic experience, investigating how different compositions could impact individuals' perceptions and emotions.
- Literature: One fourth (25%) focused on the aesthetic experience of reading and analyzing literary works, including novels, poetry, and essays.
- Video Games: One study explored the immersive experiences offered by video games, examining their potential for transformation and emotional engagement.

1.3.5.3 Description of domain of application/usage context

We identified a wide range of domains and fields of application in which transformative aesthetic experiences were examined. These included:

- Artistic context: Three studies (13%) explored the transformative potential of aesthetic experiences within live art performances, such as theater, dance performances, and other staged events. One study focused on art exhibitions and galleries, investigating how curated visual displays could lead to transformative experiences for viewers.
- Educational context: A significant body of research (30%) analyzed the role of aesthetic experiences in education, considering how art and aesthetics could enhance learning and personal development.
- Social context: Several studies (22%) explored the potential of aesthetic experiences related to their potential to influence social attitudes, empathy, and community engagement.

Table 1a: Detailed summary of the considered studies (i.e., type of study, field/domain of application, study-design, number of participants, methods/instruments used, comparison) (alphabetical order).

Title	Authors and year	Type of study	Type of artwork	Field/domain of application	Study-design	Number of participants	Method/Instrument used to detect transformation	Comparison
The Restorative and Transformative Power of the Arts in Conflict Resolution	Bang et al., 2016	Review	Visual arts, Music, Dance	Social	N.A.	N.A.	N.A.	

ART FOR CHANGE: Transformative learning and youth empowerment in a changing climate	Bentz & O'Brien, 2019	Research article	Visual arts, Storytelling	Social/Education	Uncontrolled before and after design	24	Survey, Group discussion	N.A.
Transformative Learning in the Art Museum: A Methods Review	Chisolm et al., 2020	Review	Visual arts	Education	N.A.	N.A.	N.A.	N.A.
Patterns of receptive and creative cultural activities and their association with perceived health, anxiety, depression and satisfaction with life among adults: the HUNT study, Norway	Cuypers et al., 2012	Research report	Visual arts, Poetry, Music, Dance, Theater	Social	Population-based study	50.797	Survey	N.A.
What is literature for? The role of transformative reading	Fialho, 2019	Review	Literature	N.A.	N.A.	N.A.	N.A.	N.A.
Art, Emotion, and Existential Well-Being	Funch, 2021	Review	Visual arts, Music, Movies	N.A.	N.A.	N.A.	N.A.	N.A.
Reflection, refraction, resilience: the transformative potential of art	Gaetani et al., 2022	Reflection	Music, visual arts	Education			Thematic groups, workshops	N.A.
Teaching and Learning Science for Transformative, Aesthetic Experience	Girod et al., 2017	Research article	Visual arts	Education	Quasi-experimental	N.A.	Self-report measures, Interviews	A traditional teaching method based on cognitive, rational framework
Cutting Deep: The Transformative Power of Art in the Anatomy Lab	Grogan & Ferguson, 2018	Research article	Visual arts	Education	Action research	N.A.	Interviews, Reflective Writing	N.A.
Art projects as transformative services to integrate refugees	Gross et al., 2021	Research article	Visual arts, Music	Social	Mixed-method approach	770	Survey, Semi-structured interviews	N.A.
Synchronization, Attention and Transformation: Multidimensional Exploration of the Aesthetic Experience of Contemporary Dance Spectators	Joufflineau et al., 2018	Research article	Dance performance	Art performance	Controlled before and after design	12	Two cognitive tasks, self-report measures	A dance performance not based on contemplative practice
Effects of Literature on Empathy and Self-Reflection: A Theoretical-Empirical Framework	Koopman & Hakemulder, 2015	Review	Literature	N.A.	N.A.	N.A.	N.A.	N.A.
Designing and Evaluation of an Artistic Experience for the Development of Empathic Capacity: "Stepping into Others' Shoes".	Lopez de Castro et al., 2022	Research article	Visual arts	Education	Ethnographic research	71	Reflective Writing, Focus groups	N.A.
Transformative Learning and the Arts: A Literature Review	B. Miller, 2020	Review	Visual arts, Poetry, Storytelling, Movies	Education	N.A.	N.A.	N.A.	N.A.
Experience design and the dimensions of transformative festival experiences	Neuhofer et al., 2020	Research article	Visual arts, Music, Dance	Art performance	Constructivist research design	31	Semi-structured interviews	N.A.

Transnational Refugees: The Transformative Role of Art?	O'Neill, 2008	Review	Visual arts, Poetry	Social	N.A.	N.A.	Interviews, Reflective Writing	N.A.
5x5x5=Creativity: Art as a Transformative Practice	Paris & Hay, 2019	Research article	Visual arts, Poetry	Education	Action research	N.A.	Open interviews, Reflective Journals	N.A.
Tears and transformation: feeling like crying as an indicator of insightful or "aesthetic" experience with art.	Pelowski, 2015	Research article	Visual arts	Art exhibition	Uncontrolled before and after design	79	Self-report measures	N.A.
Transformative art: art as means for long-term neurocognitive change.	Preminger, 2015	Hypothesis and theory article	Visual arts, Theater, Music, Videogames	N.A.	N.A.	N.A.	N.A.	N.A.
What Is Art Good For? The Socio-Epistemic Value of Art	Sherman & Morrisey, 2017	Review	Visual arts, Poetry, Music	N.A.	N.A.	N.A.	N.A.	N.A.
Empathy and the aesthetic: Why does art still move us?	Stamatoupolou,2018	Review	Visual arts	N.A.	N.A.	N.A.	N.A.	N.A.
Aesthetic experience models human learning	Starr, 2023	Hypothesis and theory article	Visual arts, Poetry, Music	Human Learning	N.A.	N.A.	N.A.	N.A.
Transformative experiences at art museums to support flourishing in medicine.	Tackett et al., 2023	Research article	Visual arts	Education	Uncontrolled before and after design	5	4-week course with different activities (Visual Thinking Strategies, Back-to-back sketching, Group Poems, Jazz Seminar, Reflective Writing). Reflective writings, Interviews and Self-report measures were used to evaluate the intervention.	N.A.

1.3.5.4 Psychological factors underlying aesthetic transformative experiences

1.3.5.5 Facilitating conditions

In our systematic literature review, we identified both participant-related dispositional traits and contextual design elements as facilitating conditions for transformative aesthetic experiences. Key dispositional factors included empathy, aesthetic sensitivity and openness, that is the willingness to embrace novel and diverse experiences. Pre-existing expectations (i.e., preconceived notions or anticipations about the aesthetic experience, such as expecting a profound emotional impact) and subjective preferences (i.e., individual tastes or inclinations towards certain art forms or styles) also influenced transformative outcomes.

Contextual design elements refer to the specific aspects of an environment or setting that are deliberately crafted to enhance the experience and engagement of participants (i.e., the intentional use of lighting,

soundscapes, or spatial arrangements to evoke a particular emotional or cognitive response). These elements encompass the establishment of a dialogic space (i.e., a setting that encourages open and reflective dialogue among participants), temporal and spatial liminality (i.e., the creation of a 'threshold' experience where ordinary boundaries of time and space are suspended), and innovative environments (i.e., spaces that challenge conventional perceptions and expectations). Additionally, Joufflineau et al. (2019) found that unfamiliar and uncomfortable settings (i.e., environments that provoke a sense of disorientation or challenge one's comfort zone) are particularly effective in fostering such transformation.

1.3.5.6 Physiological, cognitive and affective responses

Transformative aesthetic experiences were linked to various physiological responses, including chills, tears, and arousal. Participants exhibited slower breathing rates, suggesting a calming effect, and one study by Pelowski (2015) reported sensations of wanting to cry, highlighting the emotional depth and intensity of these encounters. Cognitive responses to transformative aesthetic experiences included heightened attention and vigilance, deep engagement or "flow", and cognitive dissonance. Moments of self-reflection and introspection were common, along with an increased focus on others and a sense of disinhibition, reported by a study by de Castro et al. (2022).

Affective responses were diverse, encompassing positive emotions such as happiness, satisfaction, and surprise, as well as fascination, wonder, and awe. Initial feelings of boredom or confusion were often followed by relief and relaxation. Affective responses also included empathetic concern and feelings of care and responsibility towards others.

1.3.5.7 Final outcome(s)

The final outcomes of transformative aesthetic experiences, which occur immediately after the experience, varied widely. Again, in the study by Joufflineau et al, (2019), participants reported a deep sense of connection and interpersonal resonance, moments of epiphany and cathartic release, and an increased tolerance for ambiguity. These encounters often led to new meanings and the challenging of established norms, accompanied by epistemic expansion and creative insight.

1.3.5.8 After-effects

Unlike final outcomes, which are immediate, aftereffects refer to the long-term, enduring changes that persist over time. The aftereffects of transformative aesthetic experiences included lasting changes in self-concept and personal growth, enhanced empathy and social awareness, and long-lasting learning and critical thinking skills. These experiences also fostered emotional development, resilience, and creativity.

For a detailed presentation and explanations of these findings, please refer to the summary table provided below (Table 1b). These concepts are further elaborated and specified in the discussion section.

Table 1b: Classification of the considered studies according to facilitating conditions, physiological, affective cognitive responses, final outcomes(s) and after-effects. (alphabetical order).

Title	Authors and year	Facilitating conditions	Physiological responses	Affective responses	Cognitive responses	Final Outcome	After-effects
The Restorative and Transformative Power of the Arts in Conflict Resolution	Bang et al., 2016	Design of the experience following the principles of artist-audience synchronization	N.A.	Empathetic concern, Anxiety Reduction	Critical Reflection, Engagement, Meta-cognitive alertness	Innovation, Reflection	Long-lasting learning, Adoption of new perspective, Cooperative Relationship, Social Bounding
ART FOR CHANGE: Transformative learning and youth empowerment in a changing climate	Bentz & O'Brien, 2019	Creation of dialogic space	N.A.	Hope, Responsibility, Care, Solidarity, Serendipity, Uncertainty	Focus of attention on the self, Cognitive Dissonance, Complex dilemma	Creative Insight	Critical Thinking ability, Awareness, Sense of Empowerment, New Understanding, Values/Knowledge Reorientation
Transformative Learning in the Art Museum: A Methods Review	Chisolm et al., 2020	New and creative environment, Social Interaction	N.A.	Surprise, Fulfillment	Introspection, Critical Reflection, Cognitive challenge	Insight	Critical Thinking ability, Mindset Growth, Transformational Learning
Patterns of receptive and creative cultural activities and their association with perceived health, anxiety, depression and satisfaction with life among adults: the HUNT study, Norway	Cuypers et al., 2012	N.A.	N.A.	N.A.	N.A.	N.A.	Growth, new meaning, perceived health and well-being
What is literature for? The role of transformative reading	Fialho, 2019	N.A.	N.A.	Pleasure, Amusement, Engagement, Empathetic concern, Sympathy, Compassion	Flow, Reconceptualization, Perspective-taking	Insight into the Self/Into the Others	New sense of self, Modification of Personal Meaning
Art, Emotion, and Existential Well-Being	Funch, 2021	Aesthetic sensitivity/Disposition	N.A.	Intense and overwhelming feelings, Pleasure, Tension, Anxiety and Fascination	Deep reasoning, Heightened Awareness, Stream of Thoughts	Aesthetic catharsis, Sense of wholeness, Being-moved	Existential well-being, Emotional Stability, Life satisfaction
Reflection, refraction, resilience: the transformative potential of art	Gaetani et al., 2022	Supportive environment, openness to art and reflection	N.A.	N.A.	Reflection, Insight, Self-awareness	N.A.	New behaviors, new knowledge, understanding attitudes, endeavors, deeper appreciation of life, resilience
Teaching and Learning Science for Transformative, Aesthetic Experience	Girod et al., 2017	N.A.	N.A.	Satisfaction	Cognitive dissonance, Higher interest	Aesthetic appreciation	Self-change, Broadened Perspective, Shift of Attitude, Long-lasting Learning
Cutting Deep: The Transformative Power of Art in the Anatomy Lab	Grogan & Ferguson, 2018	N.A.	N.A.	Relief, Satisfaction	Self-Reflection, Observation, Attentional Focus	Epiphany, Cathartic Effect	Long-lasting learning, Enhanced Resilience
Art projects as transformative services to integrate refugees	Gross et al., 2021	Openness, Social interaction	N.A.	Empathetic concern, Uncertainty, Social and Positive Emotions	N.A.	Creative Insight	New understanding/Meaning, Acceptance of Diversity, Social Bounding

Synchronization, Attention and Transformation: Multidimensional Exploration of the Aesthetic Experience of Contemporary Dance Spectators	Joufflineau et al., 2018	Design of the experience following the principles of dance-spectator synchronization	Slower breathing rate, spontaneous motor-tempo, general arousal	Feelings of fascination, boredom	More attention and vigilance, Higher absorption, direction of the attention and meta-cognitive attention	Artwork-spectator synchronization, Interpersonal resonance, Liking the performance correlated with the slowing down of the Breathing Rate	N.A.
Effects of Literature on Empathy and Self-Reflection: A Theoretical-Empirical Framework	Koopman & Hakemulder, 2015	N.A.	N.A.	N.A.	Focus on the present moment, Reflection	Insight, New Meaning, Epistemic Expansion	Empathy, Self-Reflection
Designing and Evaluation of an Artistic Experience for the Development of Empathic Capacity: "Stepping into Others' Shoes".	Lopez de Castro et al., 2022	N.A.	N.A.	Satisfaction, Surprise, Concern	Self-Reflection, Disinhibition	New meaning, Breaking Boundaries	Meaning construction, Emphatic Skills, Improved Social skills, Creativity and Self-Esteem
Transformative Learning and the Arts: A Literature Review	Miller, 2020	In person facilitators	N.A.	Appreciation, Positive emotions	Imagination, disorienting dilemma, Reflection	Extra-rational knowledge, Insight	Long-lasting learning, Self/Others Awareness, Creativity skills, Empathy skills, Connection, Purposeful Chance
Experience design and the dimensions of transformative festival experiences	Neuhofer et al., 2020	Temporal and spatial liminality	N.A.	Positive emotions (awe, happiness, fulfillment)	Engagement, Flow	Epiphany, Quantum change, epistemic expansion	Cultural Identity, Sense of Community, Spiritual Growth, Meaning making
Transnational Refugees: The Transformative Role of Art?	O'Neill, 2008	Commitment, Potential and Dialogic Space	N.A.	N.A.	Awareness, Focus on the present moment, Reflection	Insight, Mutual Recognition	New knowledge, new understanding, Personal identity
5x5x5=Creativity: Art as a Transformative Practice	Paris & Hay, 2019	Dialogic Space	N.A.	N.A.	Imagination, Focus on the self	N.A.	Creativity Skills, Intellectual development, Emotional Development, Social development
Tears and transformation: feeling like crying as an indicator of insightful or "aesthetic" experience with art.	Pelowski, 2015	Pre-expectations	Feel like crying	Tension, Confusion, Relief, Happiness	Cognitive discrepancy	Insight, Meaning/Understanding, Epiphany	Schema/Self-change
Transformative art: art as means for long-term neurocognitive change.	Preminger, 2015	N.A.	N.A.	Sense of unity, wholeness, awe	Use of imagery, imagination	N.A.	Neuro-cognitive changes: enhanced brain plasticity, enhanced brain activity in parahippocampal area, changes in cognitive functions

What Is Art Good For? The Socio-Epistemic Value of Art	Sherman & Morrisey, 2017	N.A.	Chills, tears, arousal	Negative, positive, mixed emotions	Memory integration, Directed attention, Meta-cognitive awareness	Aesthetic decision, evaluation; Insight and/or epiphany, Attention directed on the self	Self-understanding (e.g., belief/schema revision), Pro-social effects (e.g., developing empathy, perspective-taking, "practice" mentalizing), Well-being/flourishing/ health, Perceptual skills (e.g., visual discrimination) Cognitive skills (e.g., creativity)
Empathy and the aesthetic: Why does art still move us?	Stamatoupolou,2018	Disposition to empathy, Value Systems and Morality	N.A.	Emotional appraisal, Both positive and negative affect, Commotion	Reflexive Awareness, Focal attention, Focus on self- Flow	Aesthetic evaluation, Re-centering of the self	Empathic Skills
Aesthetic experience models human learning	Starr, 2023	Subjective tastes, Social Interaction, Vivid Perception, Pre-expectations	N.A.	Aesthetic Pleasure, Awe, Sublime	Enhanced Imagery, Mind-wandering	Successful identification of the percept (adherent to prior expectations), Peak-shift phenomenon, Insight	Enhanced learning capacity, Creative inspiration, Disinhibition
Transformative experiences at art museums to support flourishing in medicine.	Tackett et al., 2023	Creation of an unfamiliar context	N.A.	Wonder, awe	Quiet reflection, perspective-taking	Insight, Ambiguity tolerance	Human flourishing in terms of personal and professional growth, Renewed sense of purpose, Honesty, Re-connection with inner self and others,

1.3.6 Discussion

This systematic review was conducted with two primary objectives. Firstly, we aimed to assess the extent to which art and aesthetics could be classified as elicitors of transformation, regardless of the type of artwork, the context in which they occur, or the methodological approach used to assess their transformative impact (RQ1). Secondly, we endeavored to identify the core psychological components that define transformative aesthetic experiences (RQ2). Our discussion has been structured to comprehensively address both research questions.
To achieve these objectives, we conducted an extensive review of the existing literature, encompassing studies from psychological literature as well as studies explicitly dedicated to understanding the psychological dimensions of TEs fostered by art and aesthetics. This comprehensive approach allowed us to extract valuable insights, providing a more profound understanding of the transformative potential inherent in aesthetic encounters and the fundamental psychological components that underpin them.

1.3.6.1 Beyond beauty: are art and aesthetic experiences instances of transformation?

In recent decades, there has been a notable shift in scientific inquiry that has expanded our understanding of the role of art and aesthetics in human experience. Historically, research within psychology and neuroscience primarily focused on unraveling the cognitive processes underpinning aesthetic judgments, individual preferences, and the neural mechanisms responsible for perceiving beauty. This narrow focus led to a limited perspective where art was often reduced to a matter of personal taste and subjective liking, largely sidelining its potential for profound impact (Sherman & Morrisey, 2017).

However, a significant shift occurred within psychological literature with the introduction of the concept of TEs. TEs are defined as experiences that bring about significant and lasting changes in individuals' perceptions, emotions, beliefs, and sense of self (Chirico et al., 2022). Alongside this conceptual shift, several models identified art and aesthetic experiences as potential elicitors and instances of transformation. These models provided a theoretical framework for exploring how art could serve as a catalyst for personal and societal change, ushering in a more comprehensive view of the transformative potential inherent in artistic encounters (Pelowski & Akiba, 2011; Pelowski et al., 2017).

The outcomes of this systematic review unequivocally confirm the transformative potential inherent in art and aesthetic experiences (RQ1). The comprehensive coverage of various art forms and domains within the selected studies, encompassing visual arts, dance, music, literature, and even video games, underscores the widespread occurrence of transformative encounters across diverse creative mediums. This inclusivity offers a multifaceted view of the transformative potential within art and aesthetics.

It is essential to acknowledge that a substantial portion of the studies in this review have predominantly focused on visual arts, such as paintings and sculptures. This emphasis on visual art may reflect a historical bias in privileging visual channels as a means of artistic expression and communication (Cherry, 2004; Qurbonova, 2021). Over the years, visual art has held a prominent place in the discourse surrounding aesthetic experiences and transformation, likely due to its long-standing recognition as a powerful medium for conveying and eliciting emotions (Panosky & Drechsel, 1970; Silvia, 2005; Freedberg & Gallese, 2007; Leder et al., 2004; Menninghaus et al., 2015). Consequently, the wealth of literature in the realm of visual arts highlights a legacy of research that acknowledges its transformative capacities (O'Neill, 2008; Cuypers et al., 2012; Pelowski, 2015; Preminger, 2015; Bang et al., 2016; Girod et al., 2017; Sherman & Morrisey, 2017; Grogan & Ferguson, 2018; Bentz & O'Brien, 2019; Paris & Hay, 2019; Chisolm et al., 2020; Blackburn Miller, 2020; Neuhofer et al., 2020; Funch, 2021; Gross et al, 2021; de Castro et al., 2022; Gaetani et al., 2022; Stamatoupolou, 2018; Starr, 2023, Tackett et al., 2023).

The wealth of literature in visual arts, however, does not overshadow the transformative potential that other art forms possess. The studies examining dance, music, literature, and video games signify the expanding domains and the recognition of transformation in varied creative contexts. These findings suggest that art, across its myriad forms, wields the potential to act as a potent catalyst for personal and societal change, provided that researchers explore each medium with the same vigor and thoroughness (O'Neill, 2008; Cuypers et al., 2012; Koopman & Kakemulder, 2015; Preminger, 2015; Bang et al., 2016; Sherman & Morrisey, 2017; Joufflineau et al., 2018; Neuhofer et al., 2020; Blackburn Miller, 2020; Funch, 2021; Gross et al, 2021; Gaetani, 2022; Starr, 2023). The varied foci within these studies contribute to a broader understanding of transformation through art and aesthetics, encouraging a more inclusive perspective that embraces the full spectrum of human creativity.

This expansive range of art forms not only showcases the versatile nature of transformative aesthetic experiences but also underscores the potential applicability and relevance of these experiences in multiple domains and contexts. The diverse domains and fields of application in which transformative aesthetic experiences were examined reveal the multifaceted nature of these experiences. It is noteworthy that studies

within the educational domain, that focuses on enhancing learning and personal development, have a well-established tradition, building upon the foundations laid by Mezirow (1997; 2009) and the concept of transformative learning. These studies reflect the enduring and robust interest in the educational sector in harnessing the potential of art and aesthetics for personal growth and knowledge acquisition (Girod et al., 2017; Grogan & Ferguson, 2018; Paris & Hay, 2019; Chisolm et al., 2020; Blackburn Miller, 2020; de Castro et al., 2022; Gaetani, 2022; Tackett et al., 2023).

Conversely, the expanding body of research conducted in a social context underscores a growing trend. These studies explore how transformative aesthetic experiences can convey significant messages, influence social attitudes, foster empathy, and promote community engagement (O'Neill, 2008; Cuypers et al., 2012; Bang et al., 2016; Bentz & O'Brien, 2019; Gross et al., 2021). The rising interest in social contexts signifies a realization of the persuasive power of art and aesthetics in addressing broader societal issues and inspiring collective change (Sidford, 2011; Glaveanu, 2017).

Furthermore, the various study designs found within the empirical studies identified in this systematic review contribute to a holistic comprehension of the transformative potential inherent in art and aesthetic experiences. However, it's crucial to acknowledge the variations in design and the limited use of control groups in most of studies. These factors have important implications for the strength of the evidence and our ability to draw robust conclusions.

The use of action research, quasi-experimental, mixed-method, population-based, and before-and-after designs reflects the multidimensional nature of transformative aesthetic experiences. These approaches allow researchers to capture both quantitative and qualitative aspects of transformation. The mixed-method studies, in particular, provide a richer understanding by combining numerical data with participants' narratives and reflections. This holistic approach aligns with the complex and multifaceted nature of TEs.

1.3.6.2 Pre-encounter with the arts: what are the conditions that facilitate aesthetic TE?

Our study results offer a perspective on the facilitating conditions leading to aesthetic transformation. These conditions encompassed both participant-related dispositional traits and elements linked to the design of the experiential context. Each condition is analyzed separately in the following.

The study of individual differences in art and aesthetics appreciation began with the application of psychology to education at the turn of the 20th century. These differences have often related to personality (Chamorro-Premuzic et al., 2009; Mastandrea et al., 2009; McManus & Furnham, 2006), intelligence (Chamorro-Premuzic & Furnham, 2004; Furnham & Chamorro-Premuzic, 2004), expertise (Belke et al., 2010; Silvia & Barona, 2009), and other personal traits.

In the current review, among dispositional factors, the importance of individual traits such as empathy, aesthetic sensitivity (Pelowski et al., 2015; Stamatoupolou, 2018), and openness (Gross et al., 2021; Funch, 2021)

consistently emerged. Pre-existing expectations and subjective preferences were found to influence the likelihood of transformative outcomes (Pelowski et al., 2015; Starr, 2023).

As Stamatoupolou (2019) claims, empathy, as a personality trait, contributes to transformative outcomes by enhancing an individual's ability to connect emotionally with the artwork and the experiences it portrays. This emotional connection can lead to profound personal insights and shifts in perspective, fostering greater self-awareness and understanding of others (Batson et al., 1997). Empathy enables individuals to experience the emotions conveyed through art, facilitating a deeper engagement that can potentially catalyze a TEs (Pelowski, 2015). Neuroscientific research on mirror neurons has provided additional insights into how empathy functions in the context of art (Piechowski-Jozwiak et al., 2017). Mirror neurons are a type of brain cells that respond both when an individual performs an action and when they observe the same action performed by another (Rizzolatti et al., 1999). These neurons are suggested to play a crucial role in the capacity for empathy, as they enable individuals to internally simulate and understand the experiences of others (Rizzolatti & Craighero, 2004). When engaging with art, mirror neurons may be activated as viewers perceive and emotionally resonate with the depicted actions and emotions, thus deepening their empathic response (Freedberg & Gallese, 2007). The connection between art and empathy has been explored extensively in psychological literature. Engaging with art can enhance empathic abilities by allowing individuals to vicariously experience diverse perspectives and emotions. This can lead to a greater understanding and appreciation of others' experiences, fostering social cohesion and personal growth (Goldstein & Winner, 2012). Moreover, art can serve as a powerful tool for empathy training, helping individuals to develop greater emotional intelligence and compassion (Kaplan, 2020).

Another personality trait specific to the aesthetic context that emerged is aesthetic sensitivity. This trait is defined as the capacity to perceive and appreciate beauty and compositional excellence, and to evaluate artistic merit based on aesthetic standards (Corradi et al., 2020), also plays a crucial role. Funch (2021) argues that individuals with high aesthetic sensitivity are more likely to engage deeply with art, recognizing and valuing its elements, which can lead to significant personal reflections and transformative insights. This trait allows for a more immersive and impactful aesthetic experience, as individuals are attuned to the finer aspects of the artwork that may trigger profound emotional and cognitive responses. Additionally, openness, a personality trait characterized by creativity, imagination, and curiosity, is another key factor. This facet encompasses traits such as creativity, imagination, unconventionality, and curiosity, all sub-facets associated with a heightened inclination toward aesthetic experiences (Silvia et al., 2009). In one of the studies selected for the current review, Gross et al. (2021) measured the trait of openness and found it positively correlated not only with the willingness to engage in Integrative Art Projects (IAPs) but also with the transformative effectiveness of the intervention. IAPs are structured programs that combine various forms of artistic expression, such as visual arts, music, dance, and creative writing, to foster holistic personal development and self-expression.

This result is in line with previous literature showing that openness to experience is linked to a greater propensity for aesthetic appreciation and positive encounters with art (McCrae & Costa, 1997). This trait encourages individuals to explore new ideas and perspectives, making them more receptive to the potential for transformation through aesthetic experiences (Chamorro-Premuzic et al., 2007; Silvia et al., 2009). Individuals

high in openness are more likely to seek out and engage with diverse and complex artworks, increasing the likelihood of experiencing transformative outcomes.

In addition to these traits, other factors such as cultural background, education level, and previous exposure to art may also play significant roles in shaping one's capacity for aesthetic transformation. These elements, although not always explicitly mentioned in the reviewed studies, are hypothesized to influence the depth and nature of transformative experiences (TEs) (Pelowski et al., 2019). Moreover, these factors are deeply connected to another facilitating condition identified in this review: pre-expectations. According to two studies included in our review (Pelowski, 2015; Starr, 2023), pre-expectations are defined as the preconceived notions, attitudes, and anticipations that individuals bring to an aesthetic encounter. These pre-expectations can significantly shape the way an individual engages with and responds to art. Cultural background influences pre-expectations by providing a framework of values, traditions, and norms through which art is interpreted (Darda & Cross, 2022). For instance, individuals from cultures that highly value artistic expression may approach art with a greater sense of reverence and openness, which can facilitate deeper TEs.

Education level contributes to pre-expectations by equipping individuals with the critical skills and knowledge necessary to appreciate and analyze art. Those with higher levels of education, particularly in the arts, are likely to have more sophisticated frameworks for interpreting and engaging with artistic works, which can enhance the potential for transformative outcomes. Previous exposure to art also plays a crucial role in forming pre-expectations (Leder et al., 2014). Individuals who have been frequently exposed to art are likely to have developed a richer and more nuanced understanding of aesthetic experiences. This familiarity can make them more receptive to the emotional and cognitive impacts of art, thereby increasing the willingness to commit to the experience itself and the likelihood of the transformation.

Furthermore, our findings underscore the pivotal role of contextual elements in shaping transformative experiences. Key elements include the establishment of a dialogic space within the artistic or aesthetic encounter, the introduction of temporal and spatial liminality, and the creation of new and innovative environments. The establishment of a dialogic space involves creating an environment conducive to open dialogue and exchange between participants and the artwork. This space encourages viewers to engage in reflective conversations, fostering deeper connections and understanding (Paris and Hay, 2019; Blackburn Miller, 2020). For instance, in the study by Paris and Hay (2019), this space was created through a specific participatory program that engaged new audiences with contemporary arts, design, and creativity. This program included interactive workshops, guided discussions, and collaborative art-making sessions that allowed participants to share their interpretations and responses to the artworks.

By actively involving the audience in the creative process and encouraging them to voice their perspectives, the dialogic space breaks down barriers between the artist and the viewer, transforming the encounter from a passive reception to an active, co-creative experience. This engagement not only deepens the individual's connection to the art but also facilitates mutual understanding among participants, as they are exposed to diverse viewpoints and interpretations.

Temporal liminality refers to creating an environment where participants feel detached from their usual sense of time. This can involve altering the flow of time within the experience, such as through prolonged engagement with a single piece of art or through immersive installations that blur the boundaries of time perception (Thomassen, 2015; Liedgren et al., 2023). Spatial liminality entails modifying physical elements to craft a unique and unfamiliar setting. As in the study by Neunhofer and colleagues (2020), this can be achieved by redesigning the physical space of the art venue, incorporating unexpected spatial configurations, in terms of visual aesthetics and design of the place, that stimulated the five senses and challenge participants' usual spatial perceptions (Shortt, 2015).

Interestingly, one study even suggested that unfamiliar and uncomfortable contexts could foster transformative experiences. In the study by Tackett et al. (2023), which aims at supporting the flourishing of 3rd and 4th year medical students, these settings push participants out of their comfort zones, encouraging them to confront and reflect on their discomfort, leading to potential personal growth and transformation. A notable characteristic of these settings is their emphasis on simulated high-stakes scenarios. These scenarios are designed to mimic real-life medical emergencies and complex patient interactions, which are inherently stressful and demanding. By simulating these high-pressure environments, the study aims to prepare medical students for the realities of their future careers while simultaneously fostering resilience and adaptability.

In essence, both dispositional traits and contextual design play pivotal roles in the potential for aesthetic transformation. It is not an "either-or" scenario, but rather a synergy between individual disposition and contextual elements that can unlock the full potential of art and aesthetics as catalysts for personal and societal change. This insight underscores the importance of a holistic approach when leveraging art for educational or social purposes, recognizing that a combination of factors can lead to profound and meaningful transformation in the realm of aesthetics.

1.3.6.3 During the aesthetic experience: the role of discomfort and disruption

Throughout history, artists have intentionally pushed boundaries, confronting audiences with uncomfortable truths, challenging preconceived notions, and disrupting established conventions (Walker, 1999). Similarly, viewers have often described being deeply disrupted and struck by their experiences with art.

As we explore the role of art in transformation, findings from our systematic review underlined the significance of cognitive discomfort as a powerful trigger for expanding perspectives and inciting change. Gadamer (1984) and Rothbaum et al. (1982) have asserted that this transition from discordance to self-schema transformation marks the distinction between basic perception to profound interpretation and personal development. In the realm of art, the ability to overcome discordance and achieve self-schema change serves as the demarcation line between a superficial or unfruitful interaction with art and an aesthetic experience characterized by novelty and profundity (Dufrenne, 1973; Adorno, 1984; Dewey, 2008).

While current modeling on art perception tends to focus exclusively on the moment of "aesthetic insight", or peak of harmonious pleasure – when individuals are finally able to grasp the final meaning of an artwork and to resonate with it - the true transformative potential of art and aesthetics primarily emerges firstly from discomfort and disruption, which ultimately lead to self-schema transformation and to the creation of a new belief (Pelowski & Akiba, 2011; Pelowski et al., 2017).

Drawing from the insights of Pelowski & Akiba (2011) and the more recent VIMAP model proposed by Pelowski et al. (2017), it becomes apparent that the transformative potential originates from the observer's pre-existing expectations regarding the artwork or the experience itself. The self-reflective process triggered when these expectations are disrupted marks the inception of metacognitive reevaluation, ultimately culminating in a modification of the self-schema.

Consider, for instance, an individual attending an avant-garde art exhibition with the preconceived expectation that art should conform to traditional forms and structures. Upon encountering a highly abstract and unconventional artwork that challenges these expectations, the individual experiences confusion and disorientation. This initiates a process of self-reflection as they contemplate why they find this artwork perplexing and why it does not align with their prior beliefs about art. Over time, this metacognitive revaluation may lead to a shift in their perception of art, making them more open to unconventional forms of artistic expression and, consequently, transforming their self-schema concerning art appreciation.

Also, in the context of transformative learning, as conceptualized by Mezirow (2003) and further elaborated by others, the concept of the "disorienting dilemma" holds a central place. This concept represents a critical juncture in the transformative process where individuals are confronted with a situation or information that fundamentally challenges and disrupts their pre-existing beliefs, assumptions, or expectations. It serves as a catalyst for inducing cognitive dissonance, a state characterized by the mental discomfort arising from holding conflicting or incongruent beliefs or attitudes.

The significance of discomfort and disruption as the initial stages of transformation is further validated by our findings. In his study, Pelowski (2015) accounts for the experience of feeling like crying as a physiological response to discomfort and consequent self-schema change. The author presents a dual-factor model proposing that tears result from a cognitive and physiological process initiated by an initial discrepancy in interaction with the artwork which led to feeling like crying and related emotional states (i.e., being moved). This is followed by a subsequent shift in schema or expectations, leading to resolution and, theoretically, a potential restructuring of the self.

In educational studies employing art and aesthetic experiences, students often encounter conflicting perspectives, especially when grappling with intricate subjects like climate change or complex scientific theories (Girod et al., 2017; Bentz & O'Brien, 2019) This cognitive dissonance materializes when students are presented with compelling evidence and arguments that challenge their previously held beliefs, attitudes, or existing knowledge on the topic. This dissonance typically manifests as feelings of confusion, discomfort, or even emotional tension (Girod et al., 2017).

To resolve this cognitive dissonance, individuals might embark on a process of self-reflection and discourse. If so, they engage during this phase in critical self-examination, questioning their existing beliefs while attempting to understand the reasons behind their discomfort. In this context, individuals may actively seek out additional information, participate in discussions with peers or educators, and critically assess the validity of various perspectives. Through this systematic process, they aim to reconcile the dissonance either by adapting and revising their existing beliefs or by incorporating new information into their worldview.
As we further explore, this experience of cognitive dissonance serves as a catalyst for self-reflection, the critical examination of assumptions, and a willingness to explore and embrace new viewpoints (Girod et al., 2017).

1.3.6.4 Immediate outcome of aesthetic transformation: insight and epiphany

Numerous immediate outcomes can be attributed to the experiences of cognitive dissonance and discrepancy that frequently manifest during aesthetic encounters. Central to these outcomes is the recurring theme of *insight* and *epiphany*, which can be defined as moments of sudden and profound understanding or realization.
The profound impact of art and aesthetic experiences on fostering such epiphanies has been extensively studied in the context of art therapy and art-based practices. In these settings, both the creation and appreciation of art and aesthetics have been linked to the analytical experience of insight, often described as “seeing in” (Rubin, 2011).
Furthermore, it is crucial to observe that the concept of "transformative learning," which corresponds to the notion of sudden knowledge acquisition resulting from a profound cognitive reorganization, was initially introduced by Mezirow (1997, 2003) as a fundamental element of the Transformative Theory of Learning, primarily within the educational context. This theory consists of two fundamental elements: critical reflection or critical self-reflection, which involves individuals examining their underlying assumptions, and critical discourse, where learners validate their judgments and acquire new knowledge through discussions with other adults to explore further and refine their assumptions and realizations.
In the recent conceptual analysis conducted by Chirico et al. (2022), *epistemic expansion* emerged as one of the two phenomenological components of TEs. This concept refers to the acquisition of novel forms of knowledge, impacting both the self and the external world. To illustrate, within the context of spiritual experiences, *epistemic expansion* manifests as a profound sense of self-diminishment, accompanied by a deep feeling of interconnectedness with all living beings. During peak experiences, individuals perceive the world as inherently good, beautiful, and desirable, while simultaneously realizing the harmonious resolution of previously perceived polarities and dichotomies. Conversely, near-death experiences (NDEs) often entail the dissolution of bodily boundaries, an acute comprehension of the entirety of existence, and the sensation of standing at the precipice of an irreversible threshold. Additionally, those undergoing NDEs often encounter an altered subjective perception of time, which may expand or dilate, despite the entire experience lasting only a few moments. Furthermore, perceptions of space are frequently strained, distorted, and transcended, exemplified in cases of out-of-body experiences and NDEs.

In the studies included in this review, participants often articulate how aesthetic encounters initiate insights and cognitive shifts, motivating them to explore new meanings, challenge boundaries, and question prevailing ideologies. For instance, these encounters frequently prompt individuals to challenge established norms and beliefs concerning the self, others, and the world (Pelowski, 2015; Tackett et al., 2023). In a study by Neuhofer et al. (2020), attendees at transformative experiences festivals often reported a sense of accomplishment through the exploration of their inner selves, suggesting that this exploration can lead to the unlocking of existential questions and serve as catalyst for sudden realization about the world such as a benevolent and positive place.
In the study conducted by Bentz & O'Brien (2019), art was employed instrumentally to communicate and raise profound awareness about important social and environmental issues. Participants taking part to the designed project reported a sudden discover about their "own consumerist interior", indicating a newfound insight about themselves. Others stated that they immediately "changed behavior, which led to new routines, which then led to new thoughts," or that their involvement in the project through experiential learning resulted in a "180-degree change." Consequently, participants demonstrated increased awareness about issues related to water shortages, water quality, plastic pollution, and their ecological footprint.
As highlighted by the above findings, it's important to note that encounters with art and aesthetics do not lead to the mere acquisition of knowledge but to a process by which participants construct meaning in their lives and develop a deeper understanding of themselves, others, and the world. This type of experience entails a profound shift in perceptual framework, prompting individuals to rapidly scrutinize their existing beliefs and perspectives critically. This examination enables them to adopt fresh viewpoints and accommodate novel insights and information.

Closely related to the concept of insight, another relevant outcome observed in some studies is the development of increased ambiguity tolerance among participants (Tackett et al., 2023). This suggests that transformative aesthetic experiences expand individuals' capacity to embrace complexity and navigate emotional intricacies effectively. Such an outcome underscores the potential of aesthetics to enhance individuals' ability to appreciate life's nuances and navigate uncertainty.
As we will explore in the next section, these epiphanies can have lasting effects on individuals, contributing to personal growth and heightened self-awareness and connection with others.

1.3.6.5 Long-term Aftereffects: personal growth, empathy and connection

The long-term aftereffects of transformative aesthetic experiences reveal a multifaceted spectrum of enduring personal and social growth, underscoring their profound and lasting impact on individuals. These aftereffects can be categorized across various domains, beginning with a significant shift in an individual's schema and self-concept, as a consequence of the epistemic expansion process. This transformation results in a long-lasting alteration in how individuals perceive both themselves and the world around them, as demonstrated in studies by Pelowski (2015) and Girod et al. (2017). This transformation frequently extends beyond the individual, leading to personal and professional growth, characterized by a renewed sense of purpose, increased honesty,

and improved self-esteem, as observed in research by Paris and Hay (2019), Neuhofer et al. (2020), and Tackett et al. (2023).

The aftereffects encompass interpersonal and social dimensions, as participants often report a reconnection with their inner selves and a heightened connection with others. This leads to improved empathic skills, enhanced social and cultural awareness, and a strengthened sense of community, as documented in studies by Cuypers et al. (2012), Paris and Hay (2019), Neuhofer et al. (2020), and Gross et al. (2021).

This is in line with previous literature in which art and aesthetic experiences have been recognized to have the unique ability to foster empathy and connection (Eisner, 2002; Goldstein & Winner, 2012). When we engage with art, whether through visual arts, literature, or performance, we often step into the shoes of others, experiencing the world from different viewpoints (Nussbaum, 1997). This empathetic connection has profound implications for social change: aesthetic encounters can lead to greater understanding and compassion for diverse perspectives, ultimately promoting tolerance and unity (Greene, 1995). In a world marked by division and conflict, the capacity of art to bridge gaps and generate empathy deserves attention and exploration (Zeki, 2001). These transformative encounters also foster long-term learning, honing critical thinking abilities and promoting the acceptance of diversity, thereby highlighting their profound educational and societal implications (Mezirow, 1991; Dewey, 1934).

Furthermore, transformative aesthetic experiences have a lasting impact on emotional development. They contribute to enhancing resilience, emotional intelligence, and creativity skills, as indicated by studies conducted by Bentz and O'Brien (2019).

1.3.7 Conclusions

In this review, we undertook the systematic task of synthesizing the existing literature explicitly addressing the psychological impact and components underlying TEs in the domain of art and aesthetics.

Literature increasingly converges in considering art and aesthetics as potential elicitors of transformations (Pelowski & Akiba, 2011, Pelowski et al., 2017). This established understanding highlights how engaging with art, music, literature, or nature can evoke profound emotional responses, alter our mood, and also foster deeper individual psychological changes.

However, the literature lacks a comprehensive exploration of the nature and extent of these transformations. While it is evident that aesthetic experiences can challenge perspectives and provoke thought, the specific mechanisms and breadth of these changes remain under-researched.

In conclusion, building on a previous conceptual analysis of TEs by Chirico et al. (2022) and several theoretical frameworks by Pelowski & Akiba (2011) and Pelowski et al. (2017) that evaluated the temporal sequencing of aesthetic experiences (pre-encounter, during the experience, immediate outcomes, and long-term aftereffects), the current work achieved two main objectives related to RQ2 (What are the fundamental psychological components characterizing aesthetic transformative experiences?). First, it investigated the psychological

dimensions of TEs identified by Chirico et al. (2022) within the context of aesthetic experiences. Second, it systematically examined how and when the effects of aesthetic transformation occur.

In the pre-encounter phase, we focused on the conditions that can predispose an individual to have a transformative aesthetic experience. During the aesthetic experience, we explored the role of discomfort and disruption as key elements that can catalyze change. Subsequently, we analyzed the immediate outcomes of aesthetic transformation, such as insight and epiphany, which represent moments of profound understanding and revelation. Finally, we considered the long-term effects, such as personal growth, empathy, and connection, highlighting the lasting impact of transformative aesthetic experiences.

This work not only helps to better operationalize the variables of interest in empirical experimental settings but also provides a useful framework for designing future studies. For instance, researchers and practitioners in the field can use this work to identify and measure specific pre-experimental conditions, critical experiential elements, and post-experiential outcomes, thereby facilitating a more precise design for aesthetic transformation assessment. Additionally, this work can help develop targeted interventions and educational programs that leverage the specific timing/ moment at which each psychological effect of aesthetic transformative occurs. For example, if an intervention aims to stimulate creativity and insight generation, it could be beneficial to design a task where participants first engage with aesthetic stimuli, followed by an insight generation task or assessment. Conversely, if the goal of another intervention is to strengthen the sense of belonging to a community, it might be more effective to focus on the longer period following the aesthetic experience and, therefore, longitudinal studies (Sherman & Morrissey, 2017).

Regarding RQ1, which concerns the potential to affirm the transformative nature of art and aesthetics regardless of the type of artwork, usage contexts, and the methodological approaches employed to evaluate their transformative potential, the conclusions we can draw correspond to the possible limitations of the present work. Primarily, these limitations pertain to the predominance of studies related to visual art compared to other art forms and usage contexts, as already mentioned in the discussions. This is likely due to the ease of designing studies with visual stimuli and the greater emphasis traditionally placed on visual art. This imbalance should be taken into consideration, as the prevalence of studies related to visual art skews results regarding the effects of aesthetic experiences, leading to less literature on music, dance, and other artistic forms.

Additionally, with respect to the methodological approaches, the aesthetic experiences under consideration often do not include control groups. In the present work, we found only two studies that included a control group. Although the absence of control groups does not invalidate the findings, it limits the ability to establish causal claims regarding the transformative effects of art and aesthetics. Control groups play a crucial role in distinguishing the impact of artistic or aesthetic experiences from other variables that might influence transformation (Skov & Nadal, ahead of print). This is particularly important when dealing with subjective and context-dependent phenomena like TEs.

To strengthen the evidence base in this field, future research should prioritize more rigorous study designs and more heterogeneous stimuli (visual, auditory, tactile etc.). Randomized controlled trials (RCTs) with well-defined control groups can help establish causal relationships and enhance the internal validity of findings.

RCTs offer the advantage of experimental control, allowing researchers to manipulate variables related to art and aesthetics and assess their impact systematically (Lord & Bossuyt 2009; Mohr et al., 2009). While RCTs in the context of aesthetic experiences may pose practical and ethical challenges, they remain a gold standard for determining causality (Bolier et al., 2013; Weiss et al., 2016) and closing this gap should be a guiding principle for future empirical studies.

Nevertheless, this synthesis provides only a glimpse into the richness of this field as it stands at present. The thorough analysis of both theoretical and empirical studies has enabled us to assemble a mosaic of insights that shed light on the complex nature of transformative aesthetic experiences. Our investigation also highlights the need for continued research to delve deeper into the multi-layered complexity of these experiences.

For instance, the emergence of immersive technologies, including virtual and augmented reality, as innovative ways to encounter art and aesthetics, introduces a new layer of complexity and a new frontier for research and exploration (Candy & Edmonds, 2002; von Lehn et al., 2007; Candy & Ferguson, 2014; Pizzolante & Chirico, 2022; Pizzolante et al., 2023). Furthermore, the introduction to these technologies lead to new questions about if and how they can sustain transformation or other kinds of psychological changes (Zubala et al., 2021; Neuhofer et al.,2020; Sherman & Morrisey, 2017). For example, can digital environments evoke transformative experiences similarly to traditional settings? What features of digital art or VR experiences contribute to their transformative potential? Are these transformations equivalent to those in traditional settings? Additionally, there is a need to investigate the long-term effects of technologically mediated experiences. Do they lead to sustained personal growth and social connectedness akin to traditional art forms?

These questions are critical, as more people, especially the youth, engage with these technologies. Understanding their potential can help create beneficial interventions leveraging their power.

The practical implications of this systematic review traverse multiple disciplinary boundaries, spanning the domains of psychology, education, therapy, and the arts. Acknowledging the profound potential of aesthetic experiences opens doors to enriching educational programs, therapeutic interventions, and the conception of artistic and cultural encounters. Educators, for instance, have long harnessed the transformative power of art and aesthetics to nurture critical thinking, empathy, and personal development among students (Peppler, 2010). Dewey, in his seminal work "Art as Experience" (1934), emphasized that aesthetic experience is integral to education. He argued that engagement with art fosters reflective thinking and emotional growth, encouraging individuals to perceive and interpret the world in novel ways. Through aesthetic experiences, students learn to appreciate complexity, embrace ambiguity, and develop a deeper understanding of themselves and others. Also, Mezirow's theory of transformative learning also underscores the educational value of art and aesthetics. According to Mezirow (1991), transformative learning involves a profound shift in perspective, often triggered by a disorienting dilemma that challenges existing beliefs and assumptions. Art, with its capacity to provoke and disrupt, serves as an ideal catalyst for such transformative experiences. By confronting students with new perspectives and emotional challenges, aesthetic experiences can facilitate critical reflection and promote significant personal and intellectual growth. Thus, incorporating aesthetic elements into curricula provides students with unique opportunities to engage with the world profoundly. For example, through the study and

creation of art, students can explore diverse cultural narratives, understand complex social issues, and develop a nuanced appreciation of human experiences. This approach not only enhances cognitive skills but also fosters empathy and emotional intelligence. Moreover, aesthetic education often extends beyond traditional classroom settings. Field trips to museums, art galleries, and theaters, as well as community-based art projects, provide experiential learning opportunities that reinforce classroom teachings and foster a lifelong appreciation for the arts.

In the realm of therapy, art and aesthetics can serve as powerful vehicles for emotional healing and profound personal growth. Therapists have the opportunity to explore the therapeutic utility of aesthetics, allowing individuals to express themselves in ways that may be difficult through conventional verbal communication.

For example, an individual struggling with trauma or emotional distress may find solace and healing through creating art or engaging with aesthetic experiences. The act of creating art, be it painting, sculpture, or even writing, can provide a safe and expressive outlet for exploring and confronting complex emotions (Geller, 2018). The aesthetics of the artwork itself can offer valuable insights into the individual's emotional landscape, facilitating therapeutic breakthroughs (Tsiris, 2008; Sarasso et al., 2022).

Aesthetic experiences can also be applied in group therapy settings, where participants collectively engage in creating art or experiencing art forms. This shared aesthetic journey can foster a sense of community, empathy, and support, contributing to personal growth and resilience (Kapitan et al., 2011).

Moreover, the artistic community itself holds a pivotal role in fostering social transformation, advocating for empathy, and bridging gaps among diverse populations. Artists, curators, and cultural institutions can curate immersive environments and experiences that intentionally facilitate transformative encounters, paving the way for meaningful reflection and growth (Milbrandt, 2010; Clammer, 2014; Blackburn Miller, 2000).

In conclusion, by acknowledging and harnessing the transformative potential of aesthetics, we stand to cultivate a world characterized by deeper connections, heightened empathy, and enriched human experiences. Future research endeavors should embrace interdisciplinary approaches and innovative methodologies to further illuminate the processes and far-reaching consequences of transformative aesthetic encounters.

1.3.8 Authors contributions

MP (first author), MP (second author) and AC contributed conception and planning of the systematic review. MP formulated the inclusion/exclusion criteria and identified articles relevant to the topic. MP, SB and TD performed the screening and eligibility process. MP wrote the first draft of the manuscript. All authors contributed to manuscript revision, read and approved the submitted version.

1.4 Key points of the chapter and conclusions

In summary, this chapter explored the concept of Transformative Experience (TE) from a psychological standpoint, highlighting its dynamic nature and potential to induce significant changes in perception, cognition, and emotion. This exploration is critical for the analysis of UX as an aesthetic phenomenon for several reasons. Firstly, as mentioned, the design of human-artifact interactions is progressively shifting towards understanding its transformative potential. Within the emerging discipline of experience psychology, literature on transformative experiences is fundamental for identifying the characteristics that make an experience transformative. Our initial conceptual analysis addresses this by adopting a multidisciplinary approach to identify and define the characteristics of a TE, ultimately focusing on the psychological perspective. This comprehensive analysis provides a foundational understanding of what makes an experience transformative, which is essential for exploring the aesthetic dimensions of UX.

The first study within this chapter systematically investigates the characteristics of TEs. By drawing from various disciplines, we provide a robust definition and framework for understanding TEs. This study reveals that TEs possess distinct attributes, such as the capacity to significantly alter an individual's perception, cognition, and emotional state. These insights are crucial for UX designers aiming to create experiences that not only meet functional needs but also have the potential to transform users in meaningful ways.

Secondly, this chapter's importance is further underscored by the second study, which focuses on TEs specifically elicited by art and aesthetics. While the literature increasingly acknowledges the transformative power of aesthetic experiences, there is a lack of rigorous, systematic studies that confirm this potential. Our second study addresses this gap by providing a comprehensive review of empirical research on aesthetic-induced TEs. We evaluate how art and aesthetic experiences can lead to profound personal transformations, emphasizing the unique role of aesthetics in shaping human experiences.

This study is particularly relevant for investigating UX as an aesthetic phenomenon because it highlights the integral role of aesthetics in user interactions. By confirming the transformative potential of aesthetic experiences, we establish a critical link between aesthetic design elements and their ability to induce significant changes in users. This connection is vital for UX research and practice, as it suggests that incorporating aesthetic considerations into design can enhance the overall user experience by fostering deeper emotional and cognitive engagement.

By understanding what constitutes a transformative experience and demonstrating the significant role of aesthetics in facilitating such experiences, we laid a solid foundation for examining the relevance of TEs in the context of UX. Building on this theoretical groundwork, the next chapter will delve into the broader concept of User Experience (UX), tracing its evolution and setting the stage for a detailed analysis of its aesthetic dimension. This progression will allow us to explore how the principles of transformative experiences can be applied to UX design, ultimately enhancing the impact and depth of user interactions.

2. Delving into User Experience (UX)

Having just addressed the general concept of experience and their transformative potential, we can now delve into the second core theme and aim of this thesis, that is the psychological analysis of User Experience (UX) as an aesthetic phenomenon. The objective of this second chapter is to provide a concise introduction to the concept of UX, tracing its evolution and its historical and cultural significance. The discussion begins by defining UX and detailing its progression over time, emphasizing how perceptions and definitions have shifted, as interactions between users and artifacts have become increasingly complex.

Following this, the chapter delves into the fundamental and growing role of psychology in exploring the user-artifact relationship. This section highlights also the interdisciplinary approach necessary to understand the psychological underpinnings that influence how users perceive, interact with, and respond to different artifacts within their environments.

2.1 Traditional and Emerging Definitions of User Experience

Recently, UX has witnessed a significant increase in popularity, drawing attention from a multitude of disciplines, and becoming an indispensable knowledge to anyone who wishes to design and make anything *usable*. Several of the most successful products, services - or more generally, artifacts - are credited with their success precisely because of this analysis and attention.

But what do we have to take into consideration for an artifact to be *successful*?

To elucidate this, I will reference the most recent approaches to UX and then initiate a historical discussion on the various methodologies and disciplines that have evolved in the study of human-artifact interaction.

According to the International Organization for Standardization (ISO 9241-210), UX is defined as "*the perceptions and responses of a person resulting from the use or anticipation of using a product, system or service*" (ISO-9241-210, 2010, p.3). Multiple factors are therefore included in this definition in order to emphasize its complexity.

The term *person* highlights the individuality and uniqueness of each user's engagement with artifacts, implying that individuals interact with these objects, each with their own interpretations and expectations.

The definition mentions *perceptions* and *responses*, emphasizing both immediate and broader responses from the experience of the artifact.

Thirdly, it includes a wide range of elements, such as products, systems, and services, demonstrating the wide variety of possible interactions.

Furthermore, the use of both current and expected use shows that UX extends beyond direct contact with an artifact. It covers the whole user engagement journey, from initial expectations and pre-use impressions to thoughts and responses after the experience.

Another key aspect of this definition is that it is free of either positive or negative connotations. Basically, UX refers to any experience, irrespective of its polarity.

Lastly, according to several authors (see Turner, 2017) the definition implies that the ultimate objective of UX is to fulfill and meet users' needs within the context of use of an artifact.

This perspective led to the development of various methodological approaches and the creation of innovative tools to understand the needs of the user. From one viewpoint, *User-Centered Design* (UCD) can be seen as the diamond tip of UX methodologies. UCD (User-Centered Design) aims to ensure that no aspect of the UX in interacting with a product goes unnoticed by designers (Abras et al., 2004). Achieving this involves actively engaging users throughout the artifact development process, through both UX research and design phases. This approach necessitates that the needs of users are understood and gathered even before the design of the artifact begins and are then seamlessly integrated into all stages of research and design. By prioritizing user needs from the outset, designers can tailor the development process to address these requirements effectively, ensuring that the final product aligns closely with user expectations and enhances their overall experience.

From another viewpoint, the rise of UCD is linked to the emergence of *Design for All* or *Universal Design* (DfA/UD). This approach critiques certain manifestations of UX for its tendency to standardize products and services to suit the needs of a "general user" who supposedly embodies the needs and behaviors of all potential users. DfA advocates argue that such a general user does not exist; rather, designing for a general user often excludes individuals of varying ages, cultures, and those with disabilities, each one with its specific demands (Story, 2001).

In this context, Peter Morville (2004) made a significant contribution to defining an effective User Experience (UX) that addresses the primary concerns raised by User-Centered Design (UCD) and Design for All/Universal Design (DfA/UD), thus seeking a balance between creating an artifact that is both universally accessible and attentive to the unique needs of individual users. He conceptualized UX through the metaphor of a honeycomb, aptly chosen for its resemblance to the structured yet interconnected nature of UX design. Within this framework, he organized seven crucial aspects of UX design (**Figure 2**):

- *Useful*: Any artifact should achieve the goal of usefulness and serve the genuine demands of the users; otherwise, there would be no reason for a user to utilize it.
- *Usable*: An artifact should be straightforward to utilize.
- *Desirable*: The artifact should be able to "strike" the more emotional aspect of the user by invoking favorable feelings and increasing appeal.
- *Findable*: Artifacts should be designed such that they are easily located and identified by users, allowing them to respond to their own requirements.
- *Accessible*: Artifacts should be inclusive, not discriminating, and hence accessible to those with impairments.
- *Credible*: There must be confidence and credibility in the artifact itself.
- *Valuable*: Artifacts should be able to generate value.

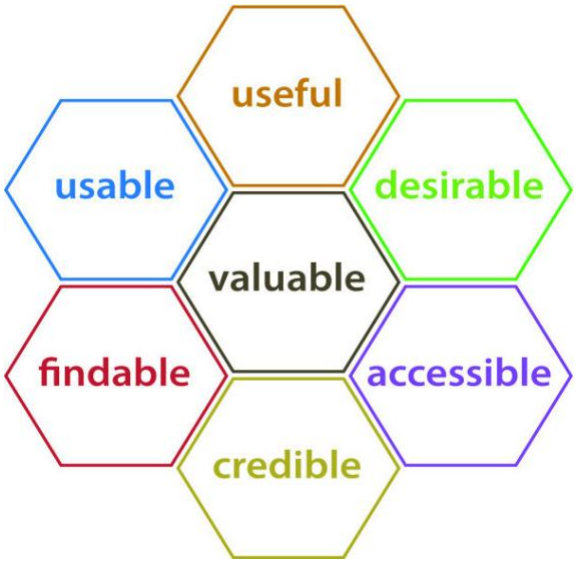

Figure 2: The honeycomb model of user experience, reproduced here with permission from Peter Morville, Semantic Studios LLC (taken by Rosenbaum et al., 2008).

As already mentioned, the study of UX has entered the field of investigation relatively recently, particularly following the evolution carried forward by approaches and theories that have focused on the study of *technologies*. Therefore, UX owes a lot to foundational concepts and ancestral disciplines that have historically focused on the study of human-technology interaction. These include the principles of *Ergonomics*, the discipline of *Human Factors/Ergonomics* (HFE), research into the acceptance of new technologies (i.e., *Technology Acceptance Model* - TAM), and the well-established concept of *usability*. Each of these areas has contributed distinct insights and methodologies that have shaped the current understanding of how users interact with artifacts. Below, I will briefly review these influential steps.

The first use of the word ergonomics dates to a newspaper article in 1857, written by the scientist Wojciech Jastrzębowski (1857). In the article, he announced the birth of a new "*work science, based on the truths drawn from the Science of Nature*" (Jastrzębowski, 1857, p. 3)

During the Second Industrial Revolution, the earliest paradigms in ergonomics emerged. Frederik Taylor (1911) pioneered the concept of "scientific management," proposing that all work could be broken down into discrete micro-activities. His goal was to identify the "one best way" to perform any task, which could then be taught to workers to enhance overall productivity. However, it wasn't until after the 1950s that ergonomics truly evolved into an independent discipline within European industry. The year of birth of contemporary ergonomics can be considered 1949 (Edholm & Murrell, 1973), when Murrel founded the *Ergonomics Research Society* in Great Britain. A few years later, in1956, the European Productivity Agency (EPA) launched a project in which all the most well-known ergonomists were invited to visit the United States, in order to observe and study the research of human factors. The seminar "*Fitting the Job to the Workers*" promoted by the EPA in the following year,

which was held at the University of Leiden in the Netherlands, laid the foundation for the birth of the *International Ergonomics Association*. Today it is possible to argue that the two disciplines have become two faces of the same coin, and many experts and historians currently refer to this area of study through the acronym HFE (Human Factors/Ergonomics) as an integrated field of research (Karwowski, 2012).

In general, HFE can be considered to be composed of three domains (Karkowski, 2012; International Ergonomics Association, 2010): *physical ergonomics*, which refers to the anatomical, anthropometric, biological and biomechanical aspects of human activities related to work; *cognitive ergonomics*, which studies mental processes (particularly perception, memory, reasoning and motor response), and the extent to which these influence the interactions between human beings and technological systems; *organizational ergonomics* (or macro-ergonomics), which involves the optimization of socio-technical systems, in terms of their organizational structures, policies and processes in order to enhance the effectiveness of working practices. Undoubtedly, although ergonomics may include all these dimensions in the consideration of well-being and/or pleasantness of activities (Wilkin, 2010), it tends to maintain the typical look of optimization of work processes. However, when modifying the interface of everyday objects —the specific organizational contexts in which they are used may not be crucial. Similarly, the concept of "performance improvement" may not always be central. It is within this framework that the concept of *usability* emerged. This concept focuses on enhancing how these objects fit into our daily lives and tasks, ensuring they are intuitive and facilitate ease of use, rather than solely optimizing for productivity outcomes.

More precisely, the International Organization for Standardization (ISO) describes the dimension of usability as characterized by three specific aspects: *effectiveness*, *efficiency* and *satisfaction* (ISO 9241-11, 2018). Effectiveness refers to the ability to achieve a predetermined goal; efficiency relates to the amount of energy and resources required for users to achieve this goal, while satisfaction pertains to the thoughts and opinions that users form based on their experiences with a specific product or service (Bevan et al., 1991; Lewis, 2014). A well-designed artifact should therefore enable users to use and engage with it without any external assistance. Good usability enables users to operate the product in the simplest possible way with the least amount of effort. The term "*user friendly*" is commonly used to describe this characteristic.

According to the Nielsen Norman Group (Nielsen, 1994), the concept of usability encompasses five specific aspects—or rather "qualities":

1. *Learnability*: How easy is it for users to perform basic actions the first time they interact with the artifact?
2. *Efficiency*: After users have understood the functionality of the product, how quickly can they complete the desired tasks?
3. *Memorability*: After a period of not using the product, how easily can users return to normal usage?
4. *Errors*: How frequent are errors? How severe are they, and how easily can they be remedied?
5. *Satisfaction*: How satisfying is the use of this product?

As a result, here, usability is primarily concerned with the product artifacts without considering the context broadly, but instead focusing on the interface and users' perceptions as they interact with the product (Nielsen, 1995; Lewis, 2012).

A user who struggles with using a product is likely to abandon it, just as someone who doesn't understand what it offers or how to use it will likely abandon it. Therefore, usability is crucial for any system, product or artifact (Quesenbery, 2014).

In both the fields of Embodied Cognition and Human-Computer Interaction, it is widely accepted that a working artifact must be transparent and cognitively undemanding for users to interact with it as if they were naturally one with it (van Dijk, 2009; Issa & Isaias, 20022). In essence, usability is the concept that allows an artifact to facilitate an effortless interaction, enabling it to facilitate human-machine communications recede, thus enabling the user to focus on achieving their goals in a fluid and natural manner (Jordan, 2020).

In summary, UX is seen as one of the final "steps" of the evolution that has influenced and has been influenced by numerous disciplines, shared by the interest in evaluating and improving technology in terms of safety, functionality, simplicity of use, and user satisfaction. It is evident that this growth has had certain distinguishing qualities; one can see, for example, an increased emphasis on the psychological aspects of the human-artifact relationship. While traditional ergonomics recognized the need to evaluate the cognitive aspects of interaction, it took nearly half a century for evaluators in the broad sense to begin systematically considering other factors such as emotions, user motivations, personality traits and personal abilities, and the complex values that the physical, social, and cultural setting might influence their perception and engagement with technology. Also, nowadays, UX includes two dimensions: UX research and UX design. The main objective of the user research dimension is to determine the user’s expectations through consideration of one’s needs and lifestyle framed in a specific sociocultural context. The human–product interaction dimension may take place in two moments: the first contact with the product and during the interaction and evaluates aesthetic, ergonomic, affective and cognitive responses to artifacts.

In general, UX tries to merge, encapsulate and combine all these aspects, representing the most open approach to the complexity of the phenomena being designed and assessed, experience of artifacts.

As a result, the foundation that allows us to investigate in this doctoral thesis UX as an aesthetic phenomenon is that it is profoundly and fundamentally psychological.

In the subsequent section, I will explore the reasons why psychology is uniquely positioned as the ideal discipline for studying UX.

2.2 Towards a psychological perspective on User Experience: the role of emotional factors

The current ISO definition of UX, with its emphasis on "people," "perceptions," and "responses," as well as "anticipation," implies and underscores that UX’s focus has indeed shifted — from disciplines dominated by

engineering and design (i.e., ergonomics and HFE) to those centered on psychological aspects of human interaction.

The preceding paragraph has helped us observe this natural transition, from an historical perspective. To give an example, the shift from the concept of *usability*, which specifically focused on objects, products, and technologies in terms of how they are perceived by users, to the term *User Experience* itself, which considers this construct as a subjective experience, placing the total emphasis of UX research and design on the user.

As a second example, if traditional ergonomics - especially, initially, in the American definition of the Human Factors - recognized the need to evaluate the cognitive aspects of interaction, late usability studies soon demonstrated how psychological factors must also be considered.

In the current paragraph I will specifically deal with those of an affective nature.

Throughout the literature on the study and evaluation of artifacts, a number of terms were started to be used to identify "non-cognitive," i.e., affective/emotional factors, and their increasingly fundamental role in interaction. Among these, we can mention *experiential needs* (Holbrook & Hirschman, 1982), *affective responses* (Derbaix & Pham, 1991), *emotional benefits* (Green & Jordan, 2003), *user delight* (Burns, Barrett, Evans, & Johansson, 2000), and simply *pleasure* (Jordan, 1998).

It was however within the discourse on usability that the affective dimension began to be recognized by scholars as a crucial psychological component of optimal tool and object performance.

It seems that users' feelings, whether they're satisfied with their interaction with technology, are no longer just a secondary factor; this was the case with traditional usability, where at most, based on ISO definition, user *satisfaction* was considered. Rather, the development of these concepts considers the fact that emotions can completely transform the experience with the artifact; more significantly, this can occur regardless of the level of other quality indicators. For instance, Queensbery (2003) identified *engagement* among *efficiency*, *effectiveness*, *error tolerance*, *ease of learning*, as a fundamental goal of usability interventions, which referred to the ability of the artifact to provide a compelling experience or to “delight” the user.

Despite this growing recognition, the incorporation and evaluation of affective components in usability studies were often conducted intuitively by practitioners. Rather than consulting with psychologists or experts in the field, many usability professionals relied on their instinctive understanding of the importance of these factors. This intuitive approach highlights a practical acknowledgment of the significance of affective elements in enhancing UX, even if not always formally articulated or methodologically rigorous.

For instance, several instruments and scales were developed to evaluate usability. From the *Streamlined Cognitive Walkthrough* and *heuristic evaluation*, which focus on identifying potential usability issues through expert reviews and systematic walkthroughs of the user interface, to more user-centered methods like the *Think-Aloud* protocol, where users verbalize their thoughts while interacting with the artifact (Lewis, 1982; Nielsen, 1994).

As for the scales, the *After Scenario Questionnaire* (ASQ) (Lewis, 1995; 1990) and the *System Usability Scale* (SUS), developed by Brooke in 1996, are prominent examples. The ASQ is designed to assess user satisfaction immediately after completing a task, focusing on specific aspects such as ease of task completion, time required,

and user satisfaction with support information. The SUS, on the other hand, provides a quick and reliable tool for measuring the overall usability of a system, producing a single score that reflects the user's perceived ease of use (Brooke, 1996). Despite the implicit consideration of affective dimensions, these tools and methods do not explicitly recognize or categorize emotional factors as separate entities. The affective component is subsumed under broader categories of user satisfaction and perceived usability, rather than being isolated and studied independently. This implicit inclusion suggests an underlying acknowledgment of the importance of emotions in usability studies, yet it stops short of a direct and systematic evaluation of affective factors (Sauro & Lewis, 2012; Albert & Tullis, 2013).

Moreover, contemporary practices and tools used to evaluate affective responses to artifacts have evolved to include a variety of methods. The primary measures employed to determine affective responses are behavioral, physiological, and subjective/self-report methods. Behavioral measures observe users' actions and reactions, which can indicate their emotional states. Physiological measures involve monitoring the autonomic nervous system's responses, such as cardiovascular variables, respiratory changes, or eye movements, as well as electrochemical activations at the cortical level. These measures provide objective data on the user's emotional state but require specific expertise in handling the instrumentation and distinguishing physiological activations unrelated to emotional responses. Additionally, methodologies like those used in experimental psychology research can be introduced to evaluate affective responses. For instance, existing questionnaires like the Self-Assessment Manikin (SAM) (Bradley & Lang, 1994) or the Aesthetic Emotion Scale (AESTHEMOS) (Schindler et al., 2017) can be utilized to assess emotional reactions. These self-report tools allow users to express their feelings and emotions in a structured manner, offering valuable insights into their affective experiences with the artifact. Despite the potential richness of physiological measures, their use in evaluating affective responses is relatively rare. Furthermore, in the development of UX practices, which are often applied to evaluate the market launch of an artifact, there has been a growing recognition of how affective states can influence user behavior. These practices not only consider the affective aspect but take it a step further by examining how this dimension can impact users' willingness to approach the artifact, use it, and incorporate it into their daily routines.

On one hand, it is undoubtedly positive emotions that draw us closer to a particular object, and this "positive" approach can influence the overall quality of use: we will spend more time learning how to use an object that we care about or that gives us positive sensations; and, very often, we will be more forgiving even when we come to notice its flaws. Also, evidence showed that users are more likely to make a purchase when they feel a positive emotional connection to the product or service. According to Jordan (2000), there are four sources of product pleasure, Norman (2004) discusses three cognitive levels of pleasurable product experiences, Desmet (2008) proposes nine ways to appeal to products, and Arrasvuori, Boberg, and Korhonen (2010) categorized 22 ways products elicit playfulness.

Similarly, users who feel frustrated or confused are more likely to abandon a product or service. On the other hand, negative emotions could have a specific role in interaction. Specifically, promoting positive emotions/affections should not always be a goal for design projects.
As an example, gloomy music makes listeners feel melancholic, shock art may disgust or outrage viewers, and movies even evoke a range of positive and negative emotions (Tan, 1996).

2.3 Key points of the chapter and conclusions

Summarizing the many methods and disciplines mentioned so far, research on human-artifact interaction has progressed towards acknowledging the complexity of this relationship. Over time, this field has evolved from focusing solely on efficiency and functionality to incorporating affective responses and their relationship with behavioral outcomes. This shift reflects a broader understanding of the multifaceted nature of user interactions with artifacts. The interdisciplinary research conducted on this topic has significantly enriched our comprehension of these interactions, with psychological perspectives playing a crucial role.
The psychological perspective has been particularly influential in the study of UX, positioning itself as a key discipline for analyzing user experiences. This is due to psychology's core focus on understanding human behavior and experience. As discussed in Chapter 1, the transformative potential of experiences is deeply rooted in psychological theories. This foundation is essential for exploring UX as an aesthetic phenomenon, as it provides the tools to analyze how users perceive, interpret, and emotionally engage with artifacts.
As I have outlined in the final part of the chapter, User Experience Psychology (UXP) is an emerging perspective that continues to grow in relevance. UXP addresses current needs in user experience design by incorporating theories and models from various psychological domains. This multidisciplinary approach ensures a comprehensive understanding of the factors that influence user interactions. In this thesis, the importance of the psychology of aesthetics is emphasized as a fundamental component of UX, positioning user experience as an inherently aesthetic phenomenon.
The heart of this thesis lies in the assertion that UX is profoundly an aesthetic experience. This perspective is critical for several reasons. First, it aligns with the current trend in UX research and design, which increasingly focuses on perceptual, affective and cognitive components. Second, it bridges theoretical concepts with practical applications, providing designers with insights into creating more engaging and satisfying user experiences. By understanding the aesthetic dimensions of UX, we can better comprehend how artifacts evoke emotional responses and how these responses translate into behavioral outcomes.
In the following chapter, we will delve deeper into the discipline of the psychology of aesthetics. Chapter 3 will trace the historical evolution of this field, from its origins to contemporary developments, demonstrating its relevance to UX. This exploration will provide a comprehensive overview of how aesthetic experiences have been studied psychologically and their implications for user experience design. By doing so, the aim to establish

a framework for understanding UX as an aesthetic phenomenon, grounded in psychological theory and empirical research.

Thus, the next chapter will also provide insights into the psychology of aesthetics, its historical development, and its application in contemporary UX research and design. This foundational knowledge will be crucial for demonstrating how aesthetic experiences shape user interactions and for guiding the creation of more impactful and transformative UX.

3. Aesthetic Experience

After establishing UX is profoundly and fundamentally psychological, I now transition into the main objective sustained by this work, namely that UX is intrinsically an aesthetic experience. In this third chapter, I will demonstrate this thesis, providing hints into the underlying mechanisms of aesthetic experience which can be applied to UX. Nonetheless, both the field of UX and contemporary psychological studies of aesthetic experience operate under the assumption that humans experience and appreciate a broad variety of objects and phenomena—including utensils, commodities, designs, other people, and nature—in aesthetic terms, described as beautiful, attractive, ugly, sublime, picturesque, and so on. However, our sense of the aesthetic is a product of our evolution and to understand it, from a psychological perspective and from the point of view of a user, we need to "reverse-engineer" it. By "reverse-engineer" our aesthetic sense, I intended to suggest that we begin with the observable outputs—our aesthetic preferences and responses—and work backward to uncover the underlying psychological mechanisms that produce them. In other words, rather than starting from theoretical assumptions and moving forward, we study aesthetic reactions and preferences to identify the evolved cognitive and affective processes that give rise to them.

Therefore, I will begin by addressing the aesthetic dimension of UX, tracing its historical evolution from its initial consideration within the HCI discipline to its current significance in UX, as introduced in the previous chapter.

Then, I will explore the historical development of the psychological study of aesthetic experiences, beginning with Psychoanalysis and Gestalt.

Following this, the narrative shifts to Empirical Aesthetics, which emerged with efforts to apply experimental methods to understand aesthetic preferences and responses and finally, Neuroaesthetics, a contemporary approach that integrates insights from neuroscience to elucidate how brain processes underlie aesthetic experiences.

Lastly, the chapter addresses current research directions, particularly focusing on the importance of affective and behavioral responses in aesthetic contexts.

3.1 Introducing User Experience as an Aesthetic Phenomenon

Toward the end of the millennium, aesthetics emerged as a significant topic in human-artifact interaction, as evidenced by the release of the "Aesthetic Computing Manifesto" (Fishwick, 2003). In this manifesto, Fishwick highlights how artists have historically integrated mathematics and technology, citing examples such as Euclidean geometry in perspective drawing, Vermeer's use of the camera obscura, and Duchamp's exploration of multi-dimensional spaces. Despite these integrations, Fishwick noted the absence of a comprehensive history of aesthetic practices influencing computing. Fishwick's manifesto proposes a framework encompassing three key concepts—modality, culture, and quality—illustrating how art-based methods can enrich computing.

Modality explores interfacing with objects, an idea now crucial in fields such as HCI and UX, necessitating technological advancements for implementation. Culture, spanning various art movements and practices, offers a rich array of principles that could be innovatively applied to computing. Lastly, quality focuses on aesthetic attributes like symmetry and minimalism, suggesting that as diverse artistic representations become more economical, they will profoundly impact computing designs. Although Fishwick's manifesto specifically addresses the world of computing, the framework he proposes has direct applicability to the broader domain of human-artifact interaction. As I will elucidate in the next paragraph, his insights suggest a significant potential for incorporating aesthetics into the investigation of HCI and UX disciplines.

3.1.1 The aesthetic dimension of human-artifact interaction: an historical perspective from HCI to UX

As outlined in this chapter and to be further discussed in the forthcoming chapter dedicated entirely to aesthetic experience, the last 25 years of scientific inquiry have seen an evolution in the definitions of both UX and aesthetic experience. UX now encompasses the full spectrum of effects elicited using an artifact, which includes aesthetic experiences that now cover experiences of meaning and emotional engagement (Desmet and Hekkert, 2007). Concurrently, the study of aesthetic experience has increasingly considered dimensions that are not only perceptual but also of affective, emotional, and behavioral nature.

But how did we arrive at this point? In the previous chapter, I have outlined a general evolution concerning UX. In the following, I will introduce how the study of aesthetics has been growingly integrated into UX, starting from foundational contributions by Donald Norman, to whom a paragraph will be dedicated below.

In the early days of HCI, the aesthetic dimension was predominantly integrated through the visual modality. This era was characterized by evaluations primarily centered on visual appeal, commonly using scales such as the Visual Aesthetics of Websites Inventory (VAWI) (Thielsch et al., 2015) and the Aesthetic Usability Effect (Tuch et al., 2012) These tools primarily assessed the impact of an artifact’s visual attractiveness, adhering strictly to the principle that "aesthetics is how it looks" (Lavie and Tractinsky, 2004; Tuch et al., 2012). However, this view that aesthetic concerned only with visual pleasure was soon abandoned, as exemplified by prominent scholars in the late years of HCI and in the initial studies on usability, introducing a range of aesthetic concepts and terminology in relation to a broader function of aesthetic (Norman, 2004; Jordan, 2000).

As such, Norman (2004) popularized the 'what-is-beautiful-is-good' effect - in his own words “attractive things work better” - which has been extensively documented (for instance, in Zhou & Fu, 2007; Mahlke, 2007). This effect refers to the phenomenon where aesthetically pleasing designs are perceived to function better and are easier to use compared to less attractive designs.

Furthermore, Noam Tractinsky was also among the pioneering researchers not only question the usability-focused paradigm of HCI but to set the relationship between aesthetic and usability.

For instance, to account for this, one of his studies was conducted in Japan and subsequently replicated in Israel, aiming to empirically assess the impact of aesthetics on user interactions with ATM interfaces. Japanese

researchers established a controlled experiment wherein two ATMs were installed at the same location, identical in architecture, location, and interaction modalities, except for their interface designs. One machine featured an aesthetically pleasing interface, while the other was equipped with a visually inferior interface. Results indicated that the ATM with the superior design not only attracted more users but also enhanced customer satisfaction, whereas the less visually appealing machine garnered user complaints. Israeli researchers replicated this experiment to investigate whether aesthetic preferences held similar importance in a culturally distinct context. Contrary to their initial hypothesis that aesthetic preferences might be less significant in Israel due to cultural differences, the findings mirrored those of the Japanese study. The Israeli research concluded that aesthetic design could significantly influence the acceptability of a system (Tractinsky, 1997). The 'what-is-beautiful-is-good' was recently explained by two psychological underlying mechanisms: the halo effect and the fluency theory. The halo effect, first conceptualized by Edward Thorndike in 1920, is a cognitive bias where an observer's overall impression of a person, object, or institution influences their feelings and thoughts about that entity's character or properties. For example, if someone is seen as physically attractive, they are often also assumed to be more sociable, successful, and intelligent. This effect extends beyond physical attributes, impacting various sectors including marketing, professional evaluations, and interpersonal relations. Fluency theory, on the other hand, is based on the ease with which information is processed. When information is processed fluently, meaning it is easy to understand, people tend to have positive reactions towards it. This concept was detailed by researchers such as Reber, Schwarz, and Winkielman (2003) who found that high levels of processing fluency not only led to preferences but also to judgments that are more positive across a variety of dimensions. In practical terms, objects or interfaces that are easier to process (e.g., because they are familiar or simple) are often rated more positively because they facilitate cognitive functioning, leading to a more enjoyable experience.

After this research, a multitude of studies later explored the influence of product aesthetics on perceived usability, consistently reporting a positive relationship between aesthetic and overall UX (e.g., Kurosu & Kashimura, 1995; Tractinsky et al., 2000; Hartmann et al., 2007; Schenkman & Jönsson, 2000). Additionally, a considerable number of experimental studies have established a cause-effect relationship between aesthetics and perceived usability (e.g., Brady & Phillips, 2003; Ben-Bassat et al., 2006; Moshagen et al., 2009; Sonderegger & Sauer 2010; Sauer & Sonderegger, 2009). This 'what-is-beautiful-is-good' effect has been demonstrated across various artifacts, from design products to digital ones (Sonderegger & Sauer 2010; Mahlke & Thüring, 2007; Brady & Phillips, 2003; Ben-Bassat et al., 2006). Moreover, its generalizability across different cultural contexts underscores the universal influence of aesthetics on functionality. Regardless of the psychological mechanisms underlying the 'what-is-beautiful-is-good'-effect, there is little doubt that the effect is highly robust.

However, despite the positive shift towards aesthetics, the development of theory and practical applications within late HCI and usability paradigms faces challenges. This approach struggles to fully capture the true role of aesthetics within human-artifact interaction, which demands greater complexity and a broader understanding of the myriad meanings that aesthetics encompasses.

In contrast, with the advent of UX, aesthetic qualities that transcend traditional criteria of functionality and usability. This perspective, driven by interaction designers such as Lowgren (2002) and Lowgren and Stolterman (2004), emphasizes new ways of conveying immaterial messages and experiences through emotional friction, engaging interaction, and seductive means. Aesthetic interaction, a recurring theme, aims to create technologies that inform, challenge, delight, and excite users.

Hassenzahl's initial work signaled the beginning of a significant interest in the pragmatic-hedonic treatment of UX. According to Hassenzahl (2004), the pragmatic aspects of an artifact enable the user to accomplish tasks efficiently and effectively, addressing usability and functionality. In contrast, the hedonic aspects are sources of arousal and personal identification, determining whether users like or identify with the artifact.

Hedonic attributes, primarily related to the users' self, can be further subdivided into stimulation and identification. Stimulation involves novelty and challenge, which are essential for personal development. Identification addresses the human need to express oneself through objects, serving a self-presentational function. This function is inherently social, as individuals seek to be perceived in specific ways by others. Therefore, a product can be perceived as pragmatic due to its efficiency in achieving behavioral goals and as hedonic because it provides stimulation and identification by conveying important personal values.

Hassenzahl's theories further distinguish between "be goals" and "do goals." "Do goals" refer to the practical, task-oriented objectives that users aim to achieve with a product, aligning with the pragmatic aspects. "Be goals," on the other hand, relate to the users' desires to become a certain type of person or to experience particular emotional states, aligning with the hedonic aspects. Understanding both "be goals" and "do goals" is crucial for designing user experiences that are not only functional but also enriching and meaningful (Hassenzahl, 2010).

Other researchers, advocate for moving beyond usability to discover innovative aesthetic interactions. They suggest various playful approaches to design that address users' senses and seek richer, more expressive forms of interaction, tailored to the unique socio-cultural contexts of use (Djajadiningrat et al., 2002; Overbeeke et al., 2003; Hummels, 2007; Blythe et al., 2011) This approach aligns with use context theories found in computer-supported cooperative work (Greif 1988), participatory design (Schuler and Namioka 1993), and contextual design (Beyer and Holtzblatt 1998).

In line with this approach, McCarthy and Wright's "Technology as Experience" (2004) explores the nature of our experiences with technology, emphasizing four threads of experience: sensual, emotional, compositional, and spatio-temporal. The sensual thread involves our sensory engagement, drawing us into a pre-reflective, intuitive experience. The emotional thread highlights how emotions color and unify experiences, illustrated by their earlier research on how different hospital staff perceive patient care. The compositional thread involves reflecting on the relationships within an experience, akin to interpreting a painting. The spatio-temporal thread acknowledges that all experiences have spatial and temporal dimensions, influencing our perception of time and space. While each thread is distinct, they overlap and interdepend, offering a comprehensive understanding of aesthetic experiences (McCarthy et al., 2006).

Today, with the advent of UXP and the focus on the transformative design of user experiences, along with the psychological literature on aesthetic experience available to us, it is necessary to re-examine the role and

significance of the aesthetic dimension in our interaction with artifacts. Therefore, in light of current psychological models of aesthetics, the central thesis of this doctoral work is that the significance of aesthetics within UX is such that UX is fundamentally an aesthetic experience. These models will be presented in the current chapter, following an in-depth analysis of Norman' s theory and a brief historical overview of the psychological study of such experiences.

3.1.2 Norman's Teapots: "Attractive Things Works Better"

Donald Norman is regarded as one of the first authors, who intuitively integrates aesthetics into design.
In his book "Emotional Design" (2003), he developed a theory of emotional design, hence, proposing a framework for analyzing products in a holistic way to include their attractiveness, their behavior, and the image they present to the user - and of the owner.
In discussing the various aspects of emotional design, Norman often refers to his teapot collection. One particular teapot in this collection is completely unusable — a "coffeepot for masochists" - its handle and spout are on the same side. The second one - the *Nanna* teapot is beautiful and quite functional but does not match the efficiency of the teapot he uses every morning, which optimizes both time and energy in use. The third one, the *tilting* point, requires a really long time to be prepared. Thus, every morning, he always used to push the button of a Japanese hot pot to boil water and to prepare his tea.
So, why do the authors claim that "Attractive Things Work Better" if he does not use his beautiful teapots regularly?
Because of two reasons. First, the value of these seldom-used teapots remains high since they are considered small sculptural artworks. These pieces, while not practical in terms of their primary function, serve as examples of how aesthetic value represents something more than appreciation for an object. For the author, aesthetics, as conceptualized in this dissertation, extends beyond the initial perceptual and sensory engagement. It unfolds across various levels, progressively involving and engaging different dimensions of experience, including affective, cognitive, and behavioral aspects.
Secondly, the story of the teapots illustrates several components of product design: usability (or lack thereof), aesthetics, and practicality. In creating a product, a designer has to consider all of them.
As such, experience of an artifact surely starts with a visceral level, which pertains to our immediate, instinctive reactions to a product. In this visceral stage, judgments about liking or disliking something are made instantly, driven by innate preferences theorized to be genetically programmed, existing in the very primitive parts of the brain, and operating by pattern matching. For example, universally, people might be drawn to warm, well-lit environments and smooth, rounded objects, while reacting negatively to abrupt, loud noises or sharp objects. Here is where the Nanna teapot excels—the author could enjoy its appearance, especially when filled with the amber hues of tea.
The next layer Norman discusses is the behavioral level, which focuses on a product's functionality and ease of use. In this case, both the tilting teapot and the metal ball come out on top. This level is closely linked to the

cognitive processes involved in assessing how a product works in everyday situations, as detailed in his earlier work, “The Psychology of Everyday Design”. Interestingly, Norman incorporates an aesthetic component at this behavioral level, emphasizing not only the functionality and understandability but also the physical feel of a product, which includes tactile pleasures such as the sensation of water during a shower. This inclusion seems to contradict his earlier assertion that appearances at this level are inconsequential, thus complicating the relationship between attractiveness and functionality.

Lastly, Norman introduces the reflective level, which involves deeper cognitive engagement with a product's broader cultural and personal significance. This level considers the meanings products hold, how they relate to personal memories, and the messages they convey about one's self-image. It’s at this stage where people reflect on their experiences in relation to their past and potential future interactions, aligning closely with the more nuanced definitions of UX discussed previously.

3.2 The Psychological Roots of Aesthetic Experience

3.2.1 Origins

In everyday life, individuals regularly encounter and engage with *aesthetic experiences*. These phenomena are not confined to traditional institutional settings, i.e., museums and theaters; rather, they permeate daily life through interactions with commonplace objects and the appreciation of natural environments (Casey, 2010; Bedford, 2016). This broad accessibility of aesthetic experiences underscores their integral role in daily human experience and highlights the ubiquitous nature of aesthetics in shaping everyday perceptions and emotions. Society allocates significant amounts of time, money, and energy towards the appreciation of aesthetics, underscoring it as a fundamental component of human life.

Within scientific literatures, scholars from various disciplines, including philosophy, art history and psychology, have sought to define and understand the complex nature of such experiences.

From a psychological perspective, which is the point of view I am most interested in for the purposes of this thesis, the first certainty within the scientific study of aesthetic experiences is that the relationship between humans and aesthetics involves a “special” type of experience (Hevner, 1937; Markovic, 2012). Secondly, this interaction not only evokes a wide array of temporary emotions, memories, and thoughts but also holds the potential to impact affective states, beliefs, and affect the psycho-physiological health in the long term.

Also, although a precise and universally accepted definition of aesthetic experiences remains elusive, nowadays scholars in the field tend to converge around a shared definition.

Aesthetic experiences have been defined as a unique form of subject–object relationship, in which a particular artifact strongly engages the subject’s mind (Ognjenovi´c, 1997). Generally, aesthetic experiences can arise from interactions with various forms of art but also nature, and everyday objects. It is important to note that *aesthetic experiences* do not belong to the same category of phenomena as aesthetic preference, enjoyment, or

judgments of beauty. According to some authors, unlike appreciation and beauty judgments, which are part of daily experiences (e.g., human faces, bodies, clothes, buildings), an *aesthetic experience* represents an extraordinary state of mind. That is, the appreciation for common artifacts can generate aesthetic experiences if it transcends its biological, psychological, and social functions and adopts new aesthetic meanings in symbolic reality (Marković, 2012).

Thus, aesthetic experiences are distinguished by their ability to encompass ordinary perception, evoking an appreciation for beauty, form, or conceptual significance, and often result in a lasting impact on the individual's well-being (Cupchik & Winston, 1996).

Furthermore, when an individual engages in an aesthetic experience, a complex interplay of motivational, cognitive, and emotional processes—with related physiological, cognitive, affective, and social responses are initiated (see the VIMAP model, Pelowski et al., 2017). Within this recent framework, aesthetic experiences can be analyzed through both *bottom-up* and *top-down* dynamics. Bottom-up processes are driven by the perceptual features of the stimulus itself—such as form, color, and composition—initiating an aesthetic reaction from the primary sensory encounter. Conversely, top-down processes involve the viewer's cognitive schemas, cultural background, and personal experiences, which shape the interpretation and emotional valuation of the aesthetic object. These dual processes highlight the complexity of aesthetic experiences, suggesting that they emerge not only from the inherent properties of the artifacts but also from the subjective contributions of the observer.

However, while contemporary research in the scientific study of aesthetic experience has broadened to recognize that aesthetic experiences can be elicited by any type of artifact, historically, the psychological study of aesthetic experience predominantly concentrated on traditional forms of art, i.e., paintings and sculptures and on the analysis of *bottom-up* dimensions of aesthetic experiences. This focus was largely driven by the underlying assumption that these types of artifacts, explicitly categorized as "art", inherently possess qualities that are more likely to elicit aesthetic responses (Mastandrea, 2015). This perspective suggests that certain elements inherent in traditional art—such as composition, style, and historical context—are particularly effective in promoting specific perceptual, affective and cognitive states and/or responses.

The field of psychology has extensively examined these states/responses within the domain of aesthetic experience, adopting various theoretical frameworks and methodological approaches. Researchers predominantly directed their inquiries towards these traditional art forms, exploring how elements like composition, style, and historical context contribute to the aesthetic experience.

The following paragraphs will outline the principal psychological perspectives on aesthetic experiences as categorized by Mastandrea in the book "Psychology of Art" (2015). The author identifies four distinct approaches: (i) Psychoanalysis, (ii) Gestalt Psychology, (iii) Experimental Aesthetics, and (iv) Neuroaesthetics. Each perspective emphasizes different facets of the aesthetic experience yet collectively highlights the pivotal roles of the artist, the artifact/artwork, and the observer.

3.2.2 Psychoanalysis: Freud's Insights on Artists' Personalities

To introduce the first approach, it is necessary to briefly examine the historical context in which it originated. The atmosphere in Vienna between the 1800s and 1900s was distinctly ambivalent: on one hand, the decline of the Habsburgs plunged the empire into a state of profound political instability; on the other, a remarkable artistic and cultural blossoming propelled the Austrian capital into the future. It was within this historical and cultural context that psychoanalysis emerged and evolved.

Sigmund Freud, the father of *psychoanalysis*, extensively wrote about art and artists (Spitz, 1985; Jurist, 2006). His most significant reflections on these topics date back to the period when he was developing theories on metapsychology and personality. During these years, he composed essays contemplating how deep-seated conflicts, i.e., neuroses, libidinal impulses, and unconscious motivations, drive artists in their creation of artworks.

In his essay "Leonardo da Vinci, A Memory of His Childhood" (Freud, 1964), the author analyzes the artwork "Saint Anne, the Virgin, and the Child" by da Vinci, in which the artist chooses to depict the figure of Mary superimposed on that of Saint Anne. Freud interprets this representational choice as the artist's unconscious attempt to sublimate the pain initially caused by separation from his natural mother and subsequently from his foster care under Ser Piero da Vinci (Leonardo's alleged illegitimate father) and his wife. *Sublimation* refers to a defense mechanism that allows individuals to channel drives (typically of a sexual or aggressive content) towards behaviors considered acceptable by society, such as the creation of an artwork. Indeed, for Freud, the purpose of art and creative activity was not so much the achievement of beauty, but the opportunity to "abreact" overwhelming emotions, such as anxiety and conflicts present in the unconscious mind and bring them to awareness. The most significant contribution of psychoanalysis to the study of aesthetic experiences is that it first focused attention on the unconscious processes of the artistic experience that guide the creation of a work of art.

Freud's reflections were then further elaborated by post-Freudians. Firstly, Carl Gustav Jung (1966) who, throughout his life, coupled his psychological research with a passion for visual arts. He claimed that the creative impulse of the artist originates in the archetypes of the collective unconscious and that the artist can transform the raw materials of the unconscious into masterpieces.

According to another renowned psychoanalyst, Melanie Klein, the roots of creativity would lie in the anxieties of the depressive position and the consequent and pressing need for repair (Klein, 1987; Segal, 1989). Her student, Hanna Segal, later expanded on Klein's perspective on art, arguing that this need for internal reconstruction is rooted in the depressive position, but its enactment depends on the artist's ability to overcome situational anxiety (Segal, 1998). To do this, the artist must be able to recognize and express their own depressive fantasies and anxieties. These processes lead the artist to internally recreate a harmonious world and project it into their artwork. The observer identifies with the artist through the artwork and in this process unconsciously retraces the steps the artist has taken to regain harmony. Thus, according to Segal, it is possible to reorder, reintegrate, and enrich one's internal world even through the mere enjoyment of the artwork (Segal, 1978).

The most recent contribution from psychoanalytic art theory examined in this section, useful for our discussion, comes from Freudian-oriented psychoanalyst Graziella Magherini. Magherini was the first to analyze the *Stendhal Syndrome*, a rare psychosomatic condition characterized by dizziness, vertigo, convulsions, and hallucinations, mainly affecting tourists in the presence of extraordinarily beautiful artworks (Magherini, 1987; Magherini, 1989). The clinical picture described is not attributable to a psychopathological condition but is the result of a severe psychological imbalance experienced by the tourist during the trip, due to the possible emotional overstimulation that art can be responsible for (Magherini, 2007). In "The Stendhal Syndrome" (2003), Magherini attempts to explain this complex emotional experience, synthesizing it in the following formula:

Artistic enjoyment = Primary mother-child aesthetic experience + Uncanny + "Chosen fact" + "F"

This formula suggests that the ways in which humans enjoy art depend on the child's first encounter with the mother's voice, face, and breast (primary mother-child aesthetic experience), from the Freudian uncanny, namely a past conflictual experience so emotionally difficult to accept that it was repressed and would reemerge when certain features of the artwork (chosen facts) reactivate the memory of that experience in the observer. In this way, the observer attributes a personal emotional meaning to the artwork. The "F" variable in the formula is a constant that pertains to the formal characteristics of the artwork.

In summary, the contributions of Psychoanalysis to understanding the relationship between humans and art have been significant, particularly in examining how artists relate to their creative processes. Creation is viewed as a mechanism of sublimation with cathartic value, enabling the transformation of anxieties, shames, and fears into something new and socially acceptable. Within this framework, attention subsequently shifted to the observer. Interaction with art provides observers with an opportunity to sublimate negative experiences and reorganize their internal worlds. From this perspective, art possesses the capacity to evoke and surface past experiences, along with the intense emotions associated with them.

3.2.3 The Gestalt Theory and the Visual Perception

The relevance of Gestalt psychology is primarily attributed to its foundational studies on visual perception, mainly related to the bottom-up components of aesthetic experiences, expressed by the aristotelian principle that “the whole is greater than the sum of its parts”.

Indeed, Gestalt psychologists contend that it is erroneous to deconstruct human experience into its basic components, as the emotions, thoughts, and behaviors exhibited by individuals are the result of a complex neural organization. More precisely, scholars from the Berlin School argue that perception is an immediate, unified, and global process that is shaped by past experiences, which provide context for interpreting current stimuli. This phenomenon is facilitated by the structured organization of our nervous system (Kanizsa & Caramelli, 1988) and is governed particularly by two fundamental laws that underpin all psychic phenomena.

The first law determines that psychic phenomena occur in a field, a concept borrowed by Kurt Lewin (1942, 1943) from physics and adapted as a life space characterized by opposing forces. The second law states that psychic processes tend to achieve a state of the field that is good, defined by the balance of the forces' valences present (Mastandrea, 2015). According to *gestaltists*, such principles are applicable to all types of cognitive processes because there exists a correspondence between how we organize our visual perception, how we structure, and how all other processes that our mind can enact are articulated (i.e, *isomorphism* principle) (Arnheim, 1964).

In the realm of Gestalt psychology, particularly in the study of visual perception, it is crucial to acknowledge the seminal research on figure/ground articulation (Helson, 1933; Wertheimer, 1938) and the Laws of the formation of phenomenal units (Kohler, 1956; 1967). These Laws, which include the principles of proximity, similarity, common fate, good form, closure, continuity of direction, and the empirical factor (Kanizsa, 1986), underpin the Gestalt framework on the interplay between humans and art (for the full explanation of Principles of Gestalt psychology, see Koffka, 2013)

Rudolf Arnheim, notably, emphasizes the significance of the principle of good form and the theory of expression in interpreting artistic phenomena (Arnheim, 1954; 1974).

The principle of good form suggests that humans possess an innate predisposition toward artifacts that demonstrate harmony, regularity, symmetry, and salience. This principle argues that such characteristics foster a perceptual balance within the figure, appealing to the observer's aesthetic sensibilities. The psychological basis for this inclination can be linked to cognitive processes that favor order and predictable patterns, facilitating easier cognitive processing and a more immediate aesthetic appreciation. Furthermore, Arnheim extends his discourse beyond aesthetic appreciation for good form to consider the expressive qualities of aesthetic artifacts—those attributes that convey the content and meanings of artworks which intuitively anticipated the study of the top-down components of aesthetic experiences. He elucidates this concept with the example of the weeping willow. According to Arnheim (1954; 1974), this tree is perceived as sad not because it physically resembles a sorrowful human, but because its form and structure metaphorically echo the qualities associated with sadness in human experience. Thus, the "expressive quality" of an artifact combines both the affective and cognitive meanings attributed to it through its structural elements, such as lines, shapes, colors, and materials. The emotional impact of an artifact, therefore, is not a subjective interpretation but a direct and innate response. This response is influenced by how these elements interact and harmonize, effectively communicating specific emotional states or ideas to the observer. This perspective underscores the cognitive processes involved in the interpretation of art, suggesting that our responses to these expressive qualities are deeply embedded in our perceptual schema.

To sum up, Gestalt psychology significantly enhances our understanding of the bottom-up processes in aesthetic experience, emphasizing how we perceive and interpret visual stimuli before any higher processing occurs.

3.2.4 Empirical Aesthetics

Empirical aesthetics is a branch of psychology that employs scientific experimental methods to examine aesthetic experiences, focusing primarily - again - on the bottom-up dimensions of these experiences. The field gained prominence with Gustav Theodor Fechner, who was the first to apply scientific experimental methods to study how humans perceive and derive aesthetic preferences from various shapes, ranging from simple, regular polygons to complex, irregular forms. In his seminal work "Primer on Aesthetics" (1860), the author posited that aesthetic experiences are shaped by fundamental features of the stimulus, including proportion, balance, and order. These elements collectively contribute to the overall appeal of an object, influencing the observer's aesthetic response.

Building on Fechner's work, Daniel Berlyne (1971) further advanced this field by suggesting that aesthetic preferences are influenced by specific features of stimuli, termed collative properties —notably novelty, uncertainty, and complexity. Collative properties refer to the comparative aspects of stimuli that engage the viewer's attention through their uniqueness (novelty), unpredictability (uncertainty), and detail (complexity), which collectively stimulate cognitive and emotional responses.

Berlyne theorized that the processing of these properties induces in the observer a physiological arousal, that is, a neurovegetative activation that contributes to the pleasure experienced during aesthetic engagement. He posited that fluctuations in arousal levels could either increase tension or produce excitement and pleasure, acting as a reward mechanism that motivates individuals toward seeking such stimulating experiences.

However, this arousal-centric theory has faced significant criticism which argue that arousal, as a generic physiological response, inadequately addresses the aesthetic quality of stimuli and the individual differences in observers' perceptions. Additionally, the initial focus of Berlyne and Fechner on experimental rigor, often at the expense of ecological validity, limited their studies to simple stimuli that poorly represented the complexity of real-world artifacts. This approach also neglected to account for individual differences in familiarity with collative properties among experimental subjects (Mastandrea, 2015).

In response to these limitations, subsequent research in empirical aesthetics has incorporated individual characteristics such as artistic expertise and/or training and personality traits like openness to experience and sensation seeking.

For example, further evidence suggests that those with greater artistic training prefer more complex and asymmetrical visual forms (Locher & Nodine, 1989; Martindale & Moore, 1988; McWhinnie, 1968; Silvia, 2005b), and traits such as openness and sensation seeking are often associated with a preference for abstract over figurative art (Feist & Brady, 2004; Furnham & Bunyan, 1988; Mastandrea, Bartoli, & Bove, 2009).

In conclusion, the contribution of experimental aesthetics to the investigation of aesthetic experience not only introduced the scientific experimental method into the study of aesthetic phenomena but also highlighted the role of neurophysiological factors such as arousal as intrinsic motivational forces influencing artifact preferences.

3.2.5 Neuroaesthetics

Neuroaesthetics is a relatively recent discipline that merges empirical aesthetics with cognitive and affective neuroscience (Chatterjee & Vartanian, 2014). Conceptualized for the first time by neurobiologist Semir Zeki in the 1990s, this field has gained considerable attention in recent years, as evidenced by the growing number of publications in this area. This approach aims to explore the neural foundations of aesthetic experiences, seeking to elucidate their neural underpinnings by exploring how the visual cortex and associated perceptual pathways are engaged when interacting with artifacts. Advanced neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) have been employed in mapping these processes, revealing the activation of specific neural circuits, including the dopaminergic and serotonergic pathways, which are crucial for the emotional and reward-based responses in aesthetic experiences (Vessel, Starr, & Rubin, 2012).

Chatterjee and Vartanian (2014) proposed a model delineating aesthetic experience as the outcome of interactions among three neural systems, collectively referred to as the aesthetic triad. These systems include: i) the sensorimotor system, encompassing perception and its motor components; ii) the emotional evaluation system, responsible for reward, emotions, and pleasure, heavily influenced by the dopaminergic and serotoninergic systems; iii) the semantic system, which facilitates the attribution of knowledge and meaning, influenced by cultural, contextual, and experiential factors. Functional analyses of these systems suggest that aesthetic appreciation engages diverse brain regions through a) enhanced cortical sensory processing, b) evaluative judgment via top-down processing, and c) activation of the reward circuit. This includes both cortical (i.e., anterior cingulate, orbitofrontal, and ventromedial prefrontal cortex) and subcortical structures (i.e., caudate nucleus, substantia nigra, nucleus accumbens), along with regulatory regions such as the amygdala, thalamus, and hippocampus, highlighting the complex neurobiological interplay that underpins aesthetic perception and evaluation (Nadal & Pearce, 2011).

The major contribution of neuroaesthetics thus lies in its attempt to identify the biological - structural and functional - correlates of the aesthetic experience.

However, this approach, focusing primarily on these specific facets of such experience, has not been without criticisms. The primary reliance on bottom-up processing at the expense of exploring top-down dynamics and their integrative processes has been a significant limitation. This methodological approach tends also to overlook how such neural processes might influence changes in an individual's behavior or mood, and often fails to integrate emotional responses with consequent behavioral outcomes (Cela-Conde et al., 2013; Pearce et al., 2016; Vessel, Starr, & Rubin, 2012).

This issue is indicative of a broader problem within neuroscience, where the uniqueness of neural activation is often assumed to correspond directly to specific psychological states or processes without sufficient consideration of the structural and functional correlates (Adolphs, 2015). Moreover, the integration of evidence related to these neural correlates with corresponding behavioral data remains inadequate. This critique is particularly salient within the neuroscientific approach to the study of aesthetic experiences, where the complexity of this phenomenon makes the straightforward mapping of neural activation to specific aesthetic

responses, problematic (Goede, 2014; Skov, 2018). The challenge lies in the fact that aesthetic experience is not only about the observable activation of certain brain regions; it also involves a subjective dimension that defines the essence of the experience itself. Also, aesthetic experience encompasses both an immediate sensory engagement and a more personal interaction with the artifact, mediated by individual history, cultural context, and personal relevance, which can elude straightforward neuroscientific categorization (Nadal et al., 2012).
Thus, to advance our understanding of aesthetic experiences, it is crucial to adopt a more comprehensive, holistic approach (Croft, 2011; Mastandrea, 2015; Pearce et al., 2016).
As outlined in the paragraph 3.1, current psychological models on aesthetic experiences have increasingly sought to integrate a nuanced comprehension of both neural correlates and behavioral dynamics associated with aesthetic perception. These models explore the interplay between top-down cognitive processes, such as individual interpretations and cultural influences, and bottom-up sensory responses to aesthetic stimuli (see Leder et al., 2004; Markovic, 2012; Vartanian & Skov, 2014; Pelowski et al., 2017).
Despite these advances, contemporary models often overlook the affective dimension of aesthetic experience, which includes not only cognitive and evaluative components but also motivational and behavioral dimensions (Frijda, 1986; Scherer, 2005). Furthermore, emotional responses in aesthetic contexts often manifest through prototypical experiential behaviors and physiological reactions (Tan, 2000; Cupchik, et al., 2009).
Therefore, there is a pressing need for models that more fully integrate the affective dimension as the core dimension of aesthetic experience, in line with the modern understanding of emotions as complex phenomena that weave together cognitive, evaluative, motivational, and physiological threads. In the following paragraph, I will analyze the emotional responses resulting from aesthetic encounters, examining them through the lens of current models on emotions. This analysis will further enrich our understanding of how aesthetic experiences can evoke different emotional reactions, contributing to the broader discourse on aesthetic experience.

3.3 Emotions and Behavior

The interplay between emotions and behavior is the focus of much psychological research, emphasizing how emotions can profoundly influence human actions. Despite this, aesthetic emotions have been relatively underexplored in terms of their behavioral implications. In this paragraph, I will delve into the general connection between emotions and behavior, and then outline three theoretical models that could be utilized in studying the link between emotions and behavior within the aesthetic experience. One of these models, the Stimulus-Organism-Response (S-O-R) model, has been employed in the study that will be presented next.
Functionalist theories of emotions propose that emotions are adaptive responses prompted by evolutionary pressures to meet fundamental life tasks (Ekman, 1992;1994;1999), core relational themes (Lazarus, 1991; Smith & Lazarus, 1993), situational types (Tooby & Cosmides 1990) or adaptational demands (Campos et al., 1994). According to these perspectives, emotions have evolved to help individuals to respond in an adaptive way to external stimuli, thus, these responses are intrinsically linked to behavior—they essentially prepare the organism for action in response to environmental demands (e.g., Ekman, 1992; Frijda, 1986; Izard, 1971;

Lazarus, 1991; Panskepp, 1994; Plutchik, 1980). Of the most relevant emotion theories, Frijda articulates this connection through the concept of action readiness, which he defines as a state of preparedness that adjusts an individual's interactions with the environment, enhancing or inhibiting certain actions based on the emotional context (Frijda, 1986). The link between emotions and behavior is an "intimate" one, suggesting that emotional responses are "not mere movements, but forms of behavior; modes of interaction with the environment" (1986, p. 11).

Building upon these foundational theories, this discussion integrates two influential frameworks that, to date, are the most relevant for further exploring how emotions link to behavior, potentially within the realm of aesthetic experience. These models are the Broaden-and-Build Theory of Positive Emotions and the Appraisal Tendency Framework (ATF). While the Stimulus-Organism-Response (S-O-R) model has been widely used to explain the relationship between stimuli and behavioral responses, it has certain limitations when considered in isolation. Specifically, the S-O-R framework can be critiqued for its simplicity, as it may overlook the role of top-down cognitive processes, individual differences, and contextual factors that shape the interpretation and impact of stimuli.

By integrating the S-O-R model with the Broaden-and-Build Theory and ATF, this discussion addresses these limitations. The Broaden-and-Build Theory highlights how positive emotions expand individuals' cognitive and behavioral repertoires, fostering creative problem-solving, social bonding, and resilience. This complements the S-O-R model by emphasizing the dynamic and cumulative nature of emotional responses over time, moving beyond a linear stimulus-response relationship to incorporate the transformative potential of aesthetic experiences.

Similarly, the ATF adds a nuanced understanding of how specific emotional states, guided by appraisal processes, influence cognition and behavior in goal-directed ways. It recognizes that emotions are not homogeneous but rather context-sensitive, shaped by individual evaluations of situational relevance and significance. This framework aligns with S-O-R by offering a mechanism to account for variability in responses to the same stimulus based on individual appraisals, thereby addressing the role of personal and situational differences. Together, these integrated frameworks provide a more robust theoretical foundation for understanding the interplay between emotions and behavior in the context of aesthetic experiences.

Now, we will examine each of these two models individually to better understand their contributions and relevance to this integrated approach.

The Broaden-and-Build Theory (Fredrickson, 2001; 2004) posits that positive emotions are able to expand people's capacities for thought and action in the short term and to build lasting physical, intellectual, social, and psychological resources. Indeed, it has been shown how emotions such as joy (Ellsworth & Smith, 1988; Frijda, 1986), interest (Csikszentmihalyi, 1990; Izard, 1977; Ryan & Deci, 2000; Tomkins, 1962), contentment (Izard, 1977), or love (Izard, 1977) increase an individual's propensity to play, explore, savor and integrate, or imagine future outcomes (Fredrickson, 1998; Fredrickson, 2000; Fredrickson & Branigan, 2001).

Specifically, evidence showed that joy can enhance creativity, increase openness to information, and improve problem-solving abilities by broadening the scope of attention and cognition (Ellsworth & Smith, 1988; Frijda,

1986; Fredrickson & Branigan, 2001). Interest, as explored by Csikszentmihalyi (1990), motivates individuals to engage deeply and persist in activities, facilitating learning and the development of skills—a concept central to his theory of flow. Similarly, contentment fosters an environment where individuals are more likely to savor experiences and integrate them into their personal narratives, promoting psychological well-being (Izard, 1977; Fredrickson, 2000). Furthermore, love, encompassing a range of positive interpersonal emotions, encourages the building of social bonds and supportive networks that are crucial for social and psychological resilience (Izard, 1977).

Fredrickson's work specifically outlines how these emotions contribute not only to immediate benefits but also to long-term development by enhancing individuals' capacities to develop resources that are vital for survival and flourishing (Fredrickson, 2001). For instance, the repeated activation of joy might lead to building a more optimistic outlook, interest could develop into a lasting intellectual curiosity, and love may result in deeper and more enduring relationships.

One of the limitations of this theory lies in the fact that the action tendencies identified for positive emotions are notably vague and underspecified (Fredrickson & Levenson, 1998). For example, joy has been linked to purposeless activation, interest with participation, and contentment with inactivity (Frijda, 1986).

The Appraisal Tendency Framework (Cavanaugh et al., 2007) seems instead to overcome this limitation through the concept of appraisal tendencies. According to this model, emotions are able to impact future choices and judgments, influencing information processing and leading individuals to evaluate possible future consequences by attributing to them the same emotional valence felt at the moment of information processing. This process is characterized by being oriented towards a specific goal, which would correspond to the response to the event that elicited the emotion, and by the fact that the emotional valence persists over time, becoming an unconscious perceptual lens for interpreting subsequent judgments and choices (Lerner & Tiedens, 2006).

Expanding upon foundational psychological theories, our attention shifts to the realm of aesthetic emotions and their broader behavioral implications. In the preceding discussion, we highlighted those aesthetic emotions, in contrast to utilitarian emotions that typically drive immediate, survival-oriented actions, do not always precipitate direct or easily observable actions. Nonetheless, this does not suggest that aesthetic emotions are devoid of behavioral consequences. Rather, while not necessarily inciting immediate action, aesthetic emotions can foster behavioral tendencies over time, subtly influencing how individuals interact with their environment and society. Evidence showed that aesthetic perception promotes specific behavioral tendencies such as increased pro-social one (Kou et al., 2020; Rathje et al., 2021) and pro-environmental actions (Marks et al., 2016; Kurtis, 2020), which, in turn, have been linked to prolonged engagement with aesthetic stimuli.

After a brief excursus on aesthetic emotions, the forthcoming study of this chapter aims at investigating deeper into these dynamics by employing another framework, the S-O-R (Stimulus-Organism-Response) one, a model adopted from environmental psychology that explicates the linkage between perception, emotion, and behavior. This framework proposes that a stimulus (S), such as specific architectural features or the broader physical environment, impacts the organism (O)—defined here as the emotional and cognitive states of individuals—

culminating in a behavioral response (R). This model is instrumental in mapping out how environmental cues trigger emotional reactions that, in turn, lead to various forms of behavior (Mehrabian & Russell, 1974).

By integrating the S-O-R framework with insights from the Broaden-and-Build Theory (Fredrickson, 2001) and the Appraisal Tendency Framework (Lerner & Keltner, 2000), the study seeks to offer a holistic analysis of how architectural aesthetics can influence behavioral outcomes through the potential mediating role of affective responses.

This interdisciplinary approach is expected to enhance our understanding of the complex interplay between aesthetic environments and human behavior, providing empirical support for theoretical assertions about the affective influences of architectural design. This research not only contributes to our knowledge of environmental psychology but also extends its implications to urban planning, architecture, and public policy, emphasizing the importance of aesthetic considerations in shaping healthy, socially conducive environments.

3.4 A focus on Aesthetic Emotions

To deepen our comprehension of aesthetic experiences, particularly through the lens of affective responses, it is essential to focus on the specific emotions elicited by encounters with art. Evidence suggests these emotions may qualitatively differ from general emotional responses due to their unique origins and impacts (Silvia, 2010; Xenakis et al., 2012). This necessitates a detailed exploration of the concept of "aesthetic emotions", in light of the current contemporary model on emotions.

In the field of emotion research, numerous theoretical models attempt to explain the origins and functions of emotional experiences. These include the Basic Emotion Theory (Ekman, 1992), which posits that several emotions are biologically innate and universally expressed; the psychological- constructionist model (Barrett, 2006), which argues that emotions are constructed from more basic psychological systems; and the social-constructivist approach (Averill, 1980), which views emotions as roles that are influenced by social and cultural forces. Among these varied approaches, I will refer to a particular theoretical framework that suggests emotions arise from a multi-stage process involving several coordinated components (Frijda, 1986; Lazarus, 1991; Scherer, 1984; Scherer, 2001). For instance, in the Component Process Model (CPM) (Scherer, 1984), emotions are defined as a temporary organization of all major functioning systems of the organism (i.e., central nervous system, autonomic nervous system, somatic nervous system, neuroendocrine system), in response to the evaluation of an external or internal stimulus. The process of emotional response is composed of five interconnected components: i) the cognitive component, ii) physiological activation, iii) the expressive component, iv) the motivational component, and v) subjective experience (feelings). The cognitive component, often referred to as appraisal, critically assesses the relevance of external stimuli that elicit emotional responses. This appraisal determines whether an event is perceived as threatening, beneficial, or neutral, guiding subsequent emotional reactions.

Physiological activation, also known as arousal, involves a series of autonomic responses. These responses include an increase in heart rate, alterations in breathing rhythm, elevated blood pressure, and pupil dilation, among other physiological changes. These changes prepare the organism to effectively respond to perceived environmental challenges or opportunities.

The motivational component, or action tendency, directs the organism towards specific behaviors, facilitating approach or avoidance actions based on the preceding cognitive appraisal. This component is crucial for adaptive behavior, as it aligns actions with the individual's assessed needs and goals. Finally, the component of subjective experience encompasses the internal monitoring of environmental demands and personal coping capacities. This aspect of emotion reflects an individual's personal, subjective interpretation of the emotional state, influenced by both the immediate context and past personal experiences.

To introduce the affective component in aesthetic experiences, a clear distinction can be drawn between utilitarian emotions and aesthetic emotions. According to the Component Process Model (Scherer, 2004), emotions arise from the appraisal of external or internal events that have significant relevance to an individual's needs or goals. These emotions are inherently pragmatic, prompting physiological responses such as an increase in heart rate and respiration, preparing the body for immediate, goal-directed actions thereby classifying them as utilitarian (Frijda, 1986). Conversely, aesthetic emotions do not originate from immediate practical needs (Tan, 2000). Instead, they predispose individuals towards a state conducive to contemplation, characterized by a lack of urgency in execution and the absence of direct motor responses. This contemplative state facilitates a reflective reaction that enhances thought and admiration, allowing individuals to engage with an aesthetic object and derive pleasure without the desire to acquire, control, or manipulate it (Mastandrea, 2015; Chatterjee & Vartanian, 2014).

Aesthetic emotions, thus, are primarily related to the goals of engagement with the aesthetic object rather than the outcomes of this engagement. This categorization aligns with the distinction between goal-related and outcome-related emotions and between the concepts of wanting and liking (Ortony, 1988; Berridge et al., 2009). The latter, liking, refers to a state of disinterested interest, a key characteristic of aesthetic emotions to be associated predominantly with the activity of the neural liking system, rather than the wanting system involved in goal-directed behaviors (Chatterjee, 2014).

Recent evidence in the investigation of aesthetic emotions, particularly stimulated by the work of Menninghaus and colleagues (2019), have renewed interest in studying affective responses resulting during and from aesthetic experiences, distinguishing these emotions from art-represented and art-elicited ones. This distinction also extends to emotions focused on the form or on the content of aesthetics, and from the theoretical concept of fiction-related emotions. The authors define aesthetic emotions as a full-blown discrete category of emotions, associated with subjectively felt pleasure or displeasure during the emotional episode, which significantly contribute to its appreciation and enjoyment. These emotions are intricately linked to various aesthetic virtues and types of aesthetic appeal.

Both differentiating and expanding from and upon Scherer's model (1984; 2005), authors propose that aesthetic emotions comprise five dimensions: i) cognitive appraisals; ii) subjective feeling qualities, iii) peripheral

physiological responses and neural substrates iv) expressive components, and iv) motivational tendencies. The cognitive appraisals in this context assess the personal relevance of stimuli, involving factors such as novelty, intrinsic pleasantness, relevance, agency attributions, and coping potential, among others (Clore, Ortony, & Foss, 1987; Frijda, 1986; Lazarus, 1991; Reisenzein, 2001; Russell, 2003; Russell & Barrett, 1999; Scherer, 2005; Smith & Ellsworth, 1985). These appraisals determine the intensity and quality of the emotional responses, where intrinsic pleasantness and the interplay of novelty and familiarity are particularly crucial in shaping the final outcomes of aesthetic experience.

Furthermore, intrinsic pleasantness is central to the appreciation of both natural beauty and art-related stimuli, predicting a nuanced engagement with aesthetics that encompasses sensory pleasure to include complex emotional responses. These responses may include a range of physiological reactions such as variations in heart rate, skin conductance, and facial muscle activity. Menninghaus et al. (2019) also emphasize the expressive and motivational components of aesthetic emotions, which manifest in behaviors such as laughter, tears, and other expressive acts that signify deep engagement with the artwork. The motivational aspect particularly influences the dynamics of interaction with the artwork, including approach or avoidance behaviors and the desire to prolong or repeat the aesthetic experience. This comprehensive model not only categorizes the defining features of aesthetic emotions but also elucidates the factors that elicit these emotions, their functions, and the variables that explain their diversity.

3.5 Study 1: Shaping Kindness: Does Symmetry in Architecture Promote Prosocial Behavior?

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3.5.1 Abstract

The aesthetic of our surrounding environment has a significant impact on our behavior. According to the S-O-R model, specific features characterizing the environment act as stimuli (S) that affect the internal states of people - organisms (O)-, which, in turn, drive their behavioral responses (R). Specifically, engaging with aesthetically appealing environments has been found to potentially promote positive normative outcomes such as prosocial behaviors. The present study investigates if architectural façades characterized by a specific feature typically associated with beauty - symmetry - can promote prosocial behavior compared to façades characterized by asymmetry, by applying the S-O-R model. To do so, in a within-subject design study, two sets of 360° virtual scenarios portraying both symmetric and asymmetric architectural façades were presented to 40 participants in a randomized order. Following each set of façades, participants were asked to complete an additional self-report questionnaire measuring their aesthetic emotions and to participate in a dictator game, aimed at measuring prosocial behavior. Results revealed that participants donated a larger amount of money to the recipient following the exposure to scenarios featuring symmetric façades compared to those characterized by asymmetry. However, the role of aesthetic emotions, as theorized by the S-O-R model, in mediating the perception of symmetry and the prosocial behavior was not fully confirmed.

3.5.2 Introduction

Humans are inherently sensitive to the visual appeal and arrangement of their surroundings. For instance, evidence has shown that exposure to natural environments can improve mood and well-being, leading to reduced stress levels (Ulrich, 1983; Hartig et al., 2014). Similarly, well-designed urban spaces characterized by specific features associated with beauty - i.e., symmetry, balance, natural luminance and curvilinearity- have been found to evoke positive emotional responses and a sense of harmony and restoration (Vartanian et al., 2013; 2019; Silvia & Barona, 2009).

Aside from its positive impact on emotional states and well-being, the environment can also shape human attitudes and behaviors. Indeed, research found that aesthetically pleasing environments can foster prosocial behavior, encouraging cooperation, empathy, and altruism (Berman et al., 2008; Joye & Dewitte, 2018). In contrast, poorly designed or chaotic environments may lead to feelings of discomfort and agitation, potentially

influencing negative behaviors and social interactions (Berman et al., 2012; Kim & Kaplan, 2004). Understanding the relationship between aesthetics and behavior is not only crucial for enhancing the design of our environments but also for creating spaces, both physical and virtual, that promote well-being and positive social interactions. Here, we delve into the exploration of the relationship between perception, affect and behavior drawing upon the S-O-R model as a theoretical framework (Mehrabian & Russell, 1974).

This paper is structured to initially establish the conceptual framework underpinning our investigation, explaining the components of the Stimulus-Organism-Response (S-O-R) model and the operationalization of each element within the realm of architectural façade perception. Subsequently, our Hypotheses, together with Methods, Results, Discussion and Conclusions, are presented.

3.5.3 Literature Review and Hypotheses

3.5.3.1 Conceptual Background: The S-O-R Model

The S-O-R model, derived from environmental psychology, posits that various environmental factors act as stimuli (S), influencing individuals' internal states (O), which, in turn, drive their behavioral responses (R) (Mehrabian & Russell, 1974). This model suggests that external environmental elements influence individuals' internal states, namely, emotions, perceptions and cognitive processes.

These elements play a crucial role in shaping individuals' behaviors, prompting specific actions toward and within the physical and social environment, either in a negative or a positive direction (Beatty & Ferrell, 1998; Verhagen & van Dolen, 2011).
Consider two scenarios. An environment with soothing colors, soft lighting, and comfortable furniture (S) can evoke positive internal states (O), such as feelings of relaxation and contentment. These positive internal states then lead to specific behavioral responses (R), such as engaging in friendly conversations, and approaching others more readily. On the contrary, an environment with dark colors, artificial lightning and uncomfortable furniture (S) might induce feelings of anxiety and discomfort (O), thus contributing to making people more inclined to avoid social interactions (R).

The objective of the current study is to explore the impact of a visual design feature (S) (i.e., symmetry), on emotional responses (O) which, in turn, affect prosocial behavior (R). To test for this, we chose to investigate the impact of the presence or absence of symmetry on the façades of architectural buildings. Since building exteriors are a common part of our environment and a unique form of aesthetic stimulus, they provide an ideal context to study how our surroundings and aesthetic perceptions together affect our emotions and behaviors. By analyzing the responses to symmetric versus asymmetric architectural façades, we aim to contribute to a deeper understanding of how environmental aesthetics, embodied in the symmetry of architectural designs, can influence emotional responses and subsequent prosocial behavior. This approach aligns with the S-O-R model

by providing a concrete context in which to explore the sensory processing (S) of visual features, the resulting emotional outcomes (O), and the behavioral reactions (R) in a real-world setting.

3.5.3.2 Stimulus: The Robustness of Symmetry Aesthetic Preference

The physicist Herman Weyl (1952) was the first to state that *"beauty is related to symmetry"* and, more recently, Ramachandran and Hirstein (1999) included symmetry as one of their eight laws of aesthetic experience. For instance, a study by Jacobsen and Höfel (2003) delved into participants' brain activity while engaging in classification tasks of abstract symmetric or randomic patterns (descriptive judgment) and the evaluation of their beauty (evaluative judgment). Results revealed a strong positive correlation between symmetry and beauty judgments. Similarly, Chen et al. (2011) found a significant aesthetic preference for symmetric patterns over scrambled images. Using the same stimuli of the previous study by Jacobsen and Höfel (2003), Weichselbaum, Leder & Ansorge (2018) also demonstrated that the preference for symmetry is irrespective of individuals' level of expertise in art. Furthermore, Makin, Pecchinenda, and Bertamini (2012) have employed the Implicit Association Test (IAT) to assess participant's associations between words with different extents of arousal and valence (e.g., "love" or "hate") and abstract symmetric or asymmetric stimuli. Their findings indicate that responses were quicker when positive words were linked with symmetric stimuli. Interestingly, these results were consistent across participants with varying levels of art expertise. Another study by Weichselbaum et al. (2018) made use of both the IAT and self-report questionnaires. They compared implicit and explicit evaluations of abstract symmetric and asymmetric stimuli between experts and non-experts. Confirming what was obtained by Makin, Pecchinenda, and Bertamini (2012), they found that both groups associated more rapidly positive words with symmetric stimuli regardless of artistic expertise. They also found that negative words were associated with asymmetric ones. Explicit rating scale assessments also revealed a general aesthetic preference for symmetric stimuli, although individuals with higher levels of art expertise tended to give higher ratings to asymmetric stimuli compared to non-experts. Similarly, Chen et al. (2011) also found a significant aesthetic preference for symmetric patterns over scrambled images and that this preference increased with the number of axes employed to enhance symmetry in the images. Although this preference for symmetry is observed across different cultures (Bode et al., 2017; Che et al., 2018; Makin et al., 2018), it appears that it varies depending on familiarity and type of the observed object. For what concerns familiarity, the aesthetic preference for symmetry arises especially for human faces (Little et al., 2007). Indeed, when individuals are asked to rate their preferences from more familiar to less familiar stimuli (i.e., human faces, macaque monkey faces, and abstract art), symmetry preferences were strongest for human faces and weakest for art. Relatively to the type of the object, research by Bertamini et al. (2019) explored the aesthetic preference for abstract objects (i.e., polygons) and familiar objects (i.e., individuals' faces, flowers, and landscapes) in their original form or in a manipulated one, namely when exhibiting perfect bilateral symmetry. The findings indicated a general preference for symmetry for polygons and faces, while landscapes and flowers were preferred in their asymmetric versions. As for architectural stimuli, the study conducted by Azemati et al. (2020) reported that non-experts exhibited an

aesthetic preference for asymmetric façades, contrasting with experts who tended to favor symmetric ones. Also, another study by Aydin & Mirzaei (2020) showed a strong positive correlation between symmetry and aesthetic appreciation when participants were asked to evaluate the symmetry and aesthetic of 12 buildings images.

In summary, several scientific studies have revealed that symmetry, as a general principle, tends to be associated with the concept of beauty. People tend to prefer symmetry over asymmetry, although this preference can fluctuate based on objects' type and characteristics. As for architectural stimuli, several studies showed that perceived symmetric façades or residential buildings were preferred compared to their symmetric counterparts and were associated with higher aesthetic judgments.
In the following paragraph, we will delve into the investigation of the relationship between symmetry perception and affective responses, thus moving forward to the O dimension in the S-O-R model.

3.5.3.3 Organism: Affective Responses to Symmetry

Typically, stimuli evoking a positive aesthetic evaluation also promote the elicitation of positive affective responses (Prinz, 2007; Kumar & Garg, 2010; Menninghaus et al., 2019). For instance, to take an example from another visual design feature (i.e., curvilinearity), shapes composed mostly by curves are perceived more positively, in terms of emotional valence, than shapes composed mostly by lines (Silvia and Barona 2009; Leder, Tinio & Bar, 2011).
Additionally, it is widely recognized that colors have also a strong impact on our emotions and feelings (Hemphill, 1996; Lang et al., 1993). For instance, red has been associated with excitement, orange has been perceived as distressing and upsetting, purple as dignified and stately, yellow as cheerful, and blue has been associated with comfort and security (Ballast, 2013; Kaya & Epps, 2004).
Despite the extensive research on the aesthetic preference to symmetry, there has been limited exploration of its effects on affective responses.
To our best knowledge, there is only one psychophysiological study investigating affective responses to symmetric stimuli. Indeed, Makin and colleagues (2012) found that symmetric stimuli can activate the Zygomaticus Major (ZM) muscle to a greater extent with respect to abstract random patterns. The ZM is considered a reliable indicator of emotional status (Ekman & Rosenberg, 2005), typically activated in response to positive stimuli (Winkielman & Cacioppo, 2001; Winkielman et al., 2006). However, Makin et al. (2012) subsequently claimed that this result might be due to a correlation with the forced-choice task implemented alongside the facial expression recording. Indeed, participants were also asked to classify symmetric *vs* random pattern stimuli by pressing a button. They suggest that the ZM activity was related to this task and not to a spontaneous emotional response of the symmetric stimuli *per se*.
In summary, given the robustness for symmetry preference and its association to beauty but considering the lack of evidence exploring the affective responses to symmetry, we stated Hypothesis 1. as follows:

Hypothesis 1. *Symmetric architectural façades will elicit to a higher extent positive emotions compared to asymmetric architectural façades.*

3.5.3.4 Response: Prosocial Behavior elicited by Affective Responses

A substantial body of research has consistently shown a link between positive affective states and the propensity to engage in altruistic behaviors (Fredrickson, 2001; Drouvelis & Grosskopf, 2016). Specifically, art and aesthetic fruition has long been advocated for its capacity to foster positive affective responses within individuals and wield significant influence over their subsequent attitudes and behaviors (Aknin et al., 2018; Kou et al., 2020). Some studies have revealed that fruition of aesthetic content positively correlate with various forms of pro-social engagement, such as participation in social events and acts of kindness towards strangers (Leroux & Bernadska, 2014), a greater propensity for volunteering (Risk, 2004; Polzella & Forbis, 2017), and an increased likelihood of making charitable donations (Van de Vyver & Abrams, 2018).

Aesthetic stimuli such as architectural ones, might foster empathy-related processes and social behaviors. Indeed, architecture can also act as a facilitator of social connections and interpersonal dynamics (Karim & Ferdous, 2018). For example, Baum and Palmer (2002) have evidenced that urban neighborhoods can provide "opportunity structures" for residents. The geometry of advantaged urban places can facilitate residents' walking and provide opportunities for social engagement (Baum and Palmer, 2002). Contrarily, living in badly designed neighborhoods may severely limit people's options when compared to those living in more affluent areas, due to the scarcity of resources available.

The idea that architectural design, through its aesthetic appeal, can encourage individuals to engage in prosocial behaviors has still to be, first, better defined, and secondly tested. Indeed, a theoretical conceptualization of this phenomenon and, consequently, empirical investigations of this relationship is nonexistent.

The S-O-R model can provide a reference framework within which to start investigating this phenomenon. By proposing that there exists a relationship between a stimulus and behavior, and that this relationship is mediated by the organism's perception. Thus, the model enables us to hypothesize that, in the case of architectural stimuli and prosocial behavior, emotions might play a mediating role. Starting from this perspective, we hypothesize a direct influence of architectural stimuli on prosocial behaviors and that this relationship is mediated by positive emotional responses elicited by the stimuli themselves. Therefore, we posit that:

Hypothesis 2a. Symmetric architectural façades will positively predict prosocial behavior.

Additionally, we hypothesize that:

Hypothesis 2b. Positive emotions mediate this relationship.

To test for these hypotheses, in a within-subject design study, two sets of 360° virtual scenarios portraying both symmetric and asymmetric architectural façades were presented to 40 participants in a randomized order. Following each set of façades, participants were asked to complete an additional self-report questionnaire measuring their affective states and to participate in a dictator game, aimed at measuring prosocial behavior.

3.5.4 Methods

3.5.4.1 Sample size calculation

Forty participants voluntarily took part in the study. A priori power analysis was conducted using G*Power version 3.1.9.7 (Faul et al., 2007) to determine the minimum sample size required to test the study hypothesis. Results indicated the required sample size to achieve 95% power for detecting a medium effect size, at a significance criterion of $\alpha = .05$, was N = 40 for paired samples t-test and N= 39 for linear multiple regression (mediation analysis). Thus, the obtained sample size was adequate to test the study hypothesis. The choice of a higher-than-conventional power level (0.95 instead of the more standard 0.8) was made to account for specific methodological considerations and ensure the reliability of the findings. This study relied exclusively on self-report measures to assess emotional responses, which, while valuable, are inherently limited when used without complementary physiological or behavioral data. Self-report measures primarily capture subjective evaluations and may not fully encompass the complexity of emotional states, potentially increasing variability and reducing the sensitivity of the analyses. By adopting a more conservative power threshold, we sought to mitigate these limitations, minimizing the risk of Type II errors (false negatives) and ensuring a robust capacity to detect medium effects.

3.5.4.2 Inclusion criteria

The inclusion criteria considered were the participants' age - between 18 and 50, language -as full knowledge of Italian was required.
Additionally, to ensure an unbiased sample, individuals with expertise in the field of architecture or related fields (i.e., art, design, engineering) or those enrolled in architectural and similar studies were excluded.
Moreover, participants with vestibular or neurological disorders or severe vision problems were excluded. Prior to data collection, the experimental protocol was approved by the Ethical Committee of the Università Cattolica del Sacro Cuore (Protocol Rf. number: 82-23). Each participant provided written informed consent for study participation. Written consent and all methods were carried out in accordance with the Helsinki Declaration.

3.5.4.3 Experimental stimuli

A total of 100 images depicting popular and non-popular architectural façades were selected from two image repositories, namely iStock and Pexels. These stimuli underwent classification by 30 diverse participants, comprising both architectural professionals (experts) and individuals with no formal training in architecture (non-experts). Participants were asked to evaluate each image on a scale from 1 to 10, indicating the perceived

degree of symmetry exhibited by the depicted façade (1= not symmetric; 10= completely symmetric), to indicate the type of symmetry depicted (i.e., bilateral, radial, spherical) as well as the level of the perceived familiarity of the image (1= not familiar; 10= completely familiar). Following the initial classification process, the final selection of stimuli was determined based on the aggregated scores assigned by the panel of both experts and non-experts. Specifically, images with symmetric characteristics obtaining high ratings (ranging between 9 and 10), regardless of the type of symmetry depicted, were chosen to comprise the set of 10 images representing symmetric architectural façades. Similarly, images depicting asymmetric features and receiving corresponding low scores (ranging between 1 and 3) were included in the collection of 10 images portraying asymmetric architectural scenarios (for examples of stimuli used, see **Figure 3**).

To control for possible confounding variables, namely, the presence of stimuli in the images not related to asymmetric or symmetric architectural façades (i.e., presence of streets, streetlights, bench, etc.), we added additional 20 control images into both stimulus sets. Specifically, these control images depicted indoor spaces or building interiors deliberately devoid of any distinct visual cues associated with either symmetry or asymmetry.

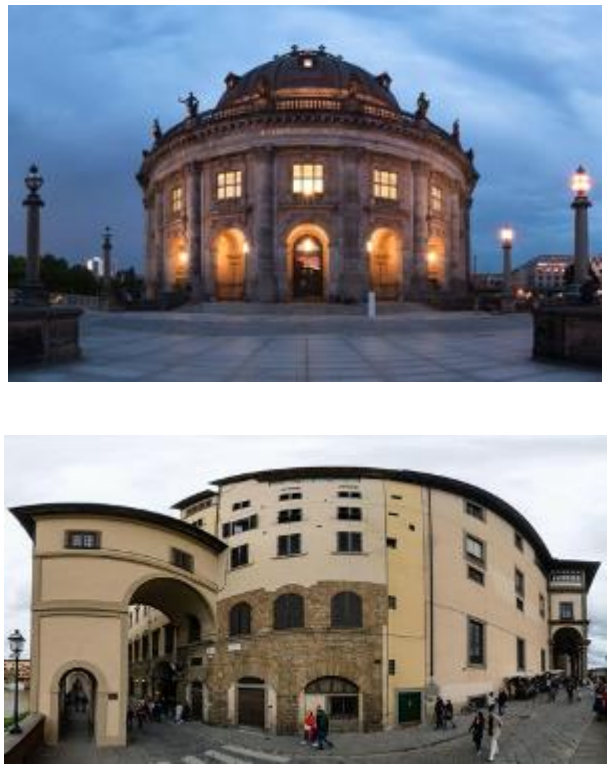


Figure 3: Examples of Architectural Façades as Study Stimuli. The image on the top represents a symmetrical facade, showcasing an orderly arrangement of elements with respect to a central axis. Conversely, the image at the bottom depicts an asymmetrical facade, characterized by an irregular arrangement of elements that eschews balance.

3.5.5 Measures and Instruments

3.5.5.1 Trait measures

Disposition to Experience Positive Emotions

Disposition to experience positive emotions was assessed before the experimental session through the Italian validation of the Dispositional Positive Emotion Scale (DPES) (Chirico, Shiota, & Gaggioli, 2021), which comprises 38 items. It is structured by seven different scales, each representing a specific positive emotion: Joy (6 items), Contentment (5 items), Pride (5 items), Love (6 items), Compassion (5 items), Amusement (5 items), and Awe (6 items). The 38 items are presented to responders in a seven-step Likert scale ranging from Strongly Disagree (1) to Strongly Agree (7). For all subscales of the Disposition for Positive Emotion scale, the minimum possible score is 0. The maximum possible score for the Joy, Love, and Awe subscales is 42, while for all other subscales it is 36.

Aesthetic Interest

Aesthetic interest was measured using the General Aesthetic Interest (DFAS) scale (Lundy et al., 2010). DFAS assesses individuals' motivation to actively seek out and engage with a wide array of aesthetic stimuli, consisting of 36 items rated on a 7-point Likert scale (1=strongly agree; 7=strongly disagree). The minimum possible score on this initial 36-item DFAS is 0, and the maximum possible score is 240. A completely neutral score would be 120, and higher scores indicate a greater desire for aesthetics in daily life.

Prosociality

The prosocial trait was measured using the Pro-socialness scale for adults (PSA) in its italian adaptation (Caprara et al., 2005) and the Balanced Emotional Empathy Scale (BEES) (Mehrabian, 1996). The PSA assesses individuals' prosocial tendencies with 16 items rated on a five-point Likert scale, ranging from 1 (never/almost never true) to 5 (almost always/always true). The BEES is a unidimensional measure of affective or emotional empathy, consisting of 30 items, with half positively worded and half negatively worded. Participants rate their agreement on a scale from −4 (very strong disagreement) to +4 (very strong agreement).

3.5.5.2 State measures

Liking and beauty ratings of the façades

Participants were asked to rate each façade on a 9-point scale based on their automatic and spontaneous feelings for each painting. Two rated dimensions served as dependent variables: beauty (1 = ugly, 5 = neither ugly nor beautiful, 9 = beautiful) and liking (1 = dislike, 5 = neither dislike nor like, 9 = like).

Positive and Negative Emotions

The Italian validation of the Positive and Negative Affect Schedule (PANAS) (Terraciano, 2003) was employed to measure participants' overall positive and negative affective states. Ratings were provided on a 5-point scale (from 1=very slightly or not at all to 5=extremely). Additionally, the Eight Discrete Emotions scale (Chirico, Cordella, Ferrise & Gaggioli, 2018) was used as a single-item Likert self-report measure to assess eight discrete emotions: anger, disgust, fear, pride, amusement, sadness, joy, and awe. Responses ranged from 1 = not at all to 7 = extremely.

Aesthetic Emotions

Aesthetic emotions were measured after the viewing of each set of scenarios using AESTHEMOS (Schindler, 2017). AESTHEMOS is organized into 21 subscales, each comprising two items designed to assess the emotional responses to perceived aesthetic appeal in a highly differentiated manner.

Prosocial Behavior

The Dictator Game, a widely used experimental instrument in social psychology and economics, was employed to assess prosocial behavior. In this revised version of the ultimatum game, participants took on the roles of "proposers". They were informed that they would receive a certain sum of money and had to decide whether and how much to share with an anonymous recipient. The allocation of the endowment constituted the dependent variable of the game (Andreoni & Bernheim, 2009).

3.5.6 Procedure

On the day of the experimental session, participants were welcomed in a room at the Department of Psychology, Università Cattolica del Sacro Cuore. They were invited to sit on a chair in front of a computer, to sign the informed consent and complete the baseline measures including trait variables (i.e., aesthetic interest, disposition to experience positive emotions, prosocial traits*)* and state variables (i.e., positive emotions). Subsequently, standardized instructions were provided to participants about the use of the Virtual Reality (VR) HMD (*MetaQuest 2*) and the experimental procedure. We chose to show the selected stimuli (i.e., 360-degree photos) using a VR headset to completely immerse participants in real-life-like environments, control over the stimuli observation time, and create a standardized experience for all participants.

Employing a within-subjects design, participants were exposed to two sets of scenarios—the first consisting of 10 symmetric architectural façades and 10 neutral stimuli, as well as the second made up of 10 asymmetric architectural façades and 10 neutral stimuli—in a counterbalanced order. Following each set of scenarios, participants removed the HMD and completed a post-experimental questionnaire pertaining to the scenarios they had just observed assessing their emotional state (i.e., aesthetic and positive emotions) and testing the

prosocial behavior with the *Dictator Game*. Upon concluding the experimental procedure, the experimenter conducted a brief debriefing session elucidating the experiment's aims and addressing any inquiries or concerns from participants. Finally, participants were thanked and dismissed.

3.5.7 Results

3.5.7.1 Data analyses

Analyses were performed using SPSS software for statistical analyses which included the package v.41.2_beta by Andrew F. Hayes for testing Mediation, Moderation, and Conditional Process Analysis. Two normality tests (i.e., Kolmogorov–Smirnov and Shapiro–Wilk) were carried out to determine if variables were normally distributed. All the variables were normally distributed except for the eight discrete emotions measured through ad-hoc items. Given the numerosity of our sample, we chose to carry out parametric statistical analyses for normally distributed variables (i.e., paired sample t-tests) and the equivalent not parametric tests for not normally distributed variables (i.e., Wilcoxon Signed Rank tests).

3.5.7.2 Description of the sample

The total sample consists of 40 participants (23 females) aged between 18 and 50 (M = 22.34, SD = ± 2.59) with no vestibular or balance disorders, no severe visual impairment and native Italian speakers. Moreover, 46.3% of participants reported to have a high school diploma, 33.6% a bachelor's degree, 14.6% a master's degree and 2.4% a second-level master's degree, as their last degree. Finally, 34.1% of participants reported having previous experiences with VR.

3.5.7.3 Trait measures

At baseline, disposition to experience positive emotions, aesthetic interest and prosociality were measured. The mean and standard deviation values for the subscales of DPES (Dispositional Positive Emotion Scale) and DFAS (Desire for Aesthetic Scale), PSA (Pro-socialness scale for adults), BEES (Balanced Emotional Empathy Scale) scales are presented in **Table 2**.

Table 2: Descriptive statistics (Mean and SD) for DPES subscales and for DFAS, PSA, BEES scales measured at the baseline.

	Mean (M)	**Standard Deviation (SD)**
DPES Joy	37.24	7.95
DPES Compassion	29.04	3.37
DPES Amusement	26.09	5.43

DPES Love	26.19	5.64
DPES Pride	30.36	5.11
DPES Awe	24.04	4.34
DFAS TOT	127.58	18.48
PSA TOT	66.00	8.05
BEES TOT	9.68	20.13

N = 40

Liking and beauty ratings of the façades

Both liking and beauty scores were higher for symmetric façades (M = 6.62; SD = 1.69), (M = 6.37; SD = 1.39) and lower for asymmetric façades (M = 3.90; SD = 1.48), (M = 4.24; SD = 1.92).

3.5.7.4 Hypothesis 1.

In order to test Hypothesis 1, two repeated measures ANOVA were conducted to compare positive and negative affects (PA, NA) measured through PANAS subscales and eight discrete emotions measured through eight ad-hoc items (**Table 3**). These measures were collected at baseline and after viewing each set of scenarios. Results showed a statistically significant difference between at least two out of three measurements with respect to NA subscale only ($F = 8.77$, $p = .00$, $\eta 2 = .18$). The post-hoc comparison - with *Bonferroni*'s correction ($\alpha = 0.05$) - showed that statistically significant differences were found between NA scores collected at the baseline (M = 15.39, SD = 5.73) with respect to both each set of scenarios, featuring symmetric façades (M = 12.46, SD = 4.29) and asymmetric façades (M= 12.35, SD = 4.27) but none difference was found between the two different sets of scenarios.

Since the eight discrete emotions were not normally distributed, several non-parametric Friedman tests were performed. Results revealed significant differences for anger ($\chi^2 = 22.79$, p= .001) amusement ($\chi^2 = 16.66$, p= .001), sadness ($\chi^2 = 8.72$, p= 0.013) and awe ($\chi^2 = 31.44$, p= .001). Subsequently, post hoc analysis with Wilcoxon signed-rank tests were conducted. When multiple statistics are applied to discover pairwise associations, it is necessary to adjust the significance levels since the probability to commit Type I errors

increases. With this regard, Bonferroni correction lowers the critical *p*-value for the Wilcoxon test, and it relies on the number of performed tests. Therefore, for adjustment, we computed the corrected level of significance ($\alpha = 0.05$) to address the multiple statistics. Since we had 3 measurements, we adjusted the significance level to 0.017 (=0.05/3) (Cabin and Mitchell, 2000) Resulted showed that both symmetric and asymmetric façades induced higher levels amusement [(Mdn1= 6, Z1= 3.004, p = .003); (Mdn2= 6, Z2= 2.955, p = .003)] and awe [(Mdn1= 6, Z1= 3.837, p = .001); (Mdn2= 6, Z2= 4.318, p = .001)] compared to the baseline (Mdn1= 4; Mdn2=3). Conversely, both set of scenarios, symmetric and asymmetric, decreased levels of anger [(Mdn1= 1, Z1= 3.225, p = .001); (Mdn2= 1, Z2= 3.342, p = .001)] and sadness [(Mdn1= 1, Z1= 2.444, p = .029); (Mdn2= 1; Z2= 2.188, p = .004)] , always compared to baseline (Mdn1= 2; Mdn2= 2). No differences were found between the two sets of scenarios.

Table 3: Descriptive statistics (Mean and SD) for PANAS subscale (PA, NA) and Eight Discrete Emotions.

	Baseline		**Symmetrical façades**		**Asymmetrical façades**	
	Mean (M)	**Standard Deviation (SD)**	**Mean (M)**	**Standard Deviation (SD)**	**Mean (M)**	**Standard Deviation (SD)**
Positive Affect (PA)	33.29	7.00	33.53	1.58	33.43	9.87
Negative Affect (NA)	15.39	5.73	12.46	4.29	12.35	4.27
Anger	1.85	1.40	1.15	.47	1.17	.44
Disgust	1.24	.69	1.05	.31	1.17	.667
Fear	2.20	1.72	1.46	1.07	1.46	1.07
Pride	3.22	1.73	2.98	1.99	2.95	2.03
Amusement	4.12	1.66	5.12	1.87	5.17	1.78
Sadness	2.00	1.37	1.56	1.28	1.41	.74
Awe	3.05	1.87	4.98	2.10	5.02	2.06

Joy	4.29	1.63	4.68	1.87	4.83	2.06

Paired samples t-test were conducted to compare the scores of the subscales of the AESTHEMOS scale after viewing each set of scenarios. Statistically significant differences were found for the subscales *nostalgia* (t = -2.01, p = .05) and *anger* (t = -1.95, p = .05). Specifically, the mean value of the subscale *nostalgia* after viewing symmetric façades (M = 2.41, SD = 1.11) was significantly lower than the mean value after viewing asymmetric façades (M = 2.71, SD = .96). Similarly, the same was observed for the subscale *anger* (M = 1.01, SD = .07; M = 1.07, SD= .21)

3.5.7.5 Hypotheses 2a and 2b

To test for Hypotheses 2a and 2b several mediation analyses were carried out. We tested the effect (path *a*,*d*) of the exposure to either the set of symmetric façades or the set of asymmetric façades (independent variable X) on PA and each positive discrete emotion (i.e., joy, amusement, awe, pride) (mediators M) and the effect (path *b*,*e*) of PA and each positive discrete emotion on the amount of money (variable Y) donated in the Dictator Game, as a measure of prosocial behavior. Additionally, we tested both the direct effect (path *c'*) of the variable X on Y and the indirect effect of PA and each discrete emotion in mediating the relationship between X and Y.

The path *a* and *d* from exposure to either symmetric façades or asymmetric façades to PA and each positive discrete emotion was not significant. Similarly, the path *b and e* from PA and each positive discrete emotion to the amount of money donated was not significant (see **Figure 4** for results). However, results show that the direct effect is significant [b = -.47; p = .02; s.e.= 4.77; (95% Cl -20.35, -.133], thus the exposure to either the set of symmetric façades or the set of asymmetric façades does predict the amount of money donated in the Dictator Game (path *c*). Specifically, a paired sample t-test revealed that after viewing symmetric façades, participants donated a significantly higher amount of money in the Dictator Game (M = 49.63, SD = 21.95) than after viewing asymmetric façades (M = 38.57, SD = 22.50). However, analyzing the indirect effect, results reveal that PA or ad hoc positive emotions does not significantly mediate the relationship between exposure to either symmetric or asymmetric façades on the amount of money (variable Y) donated in the Dictator Game (path *c'*).

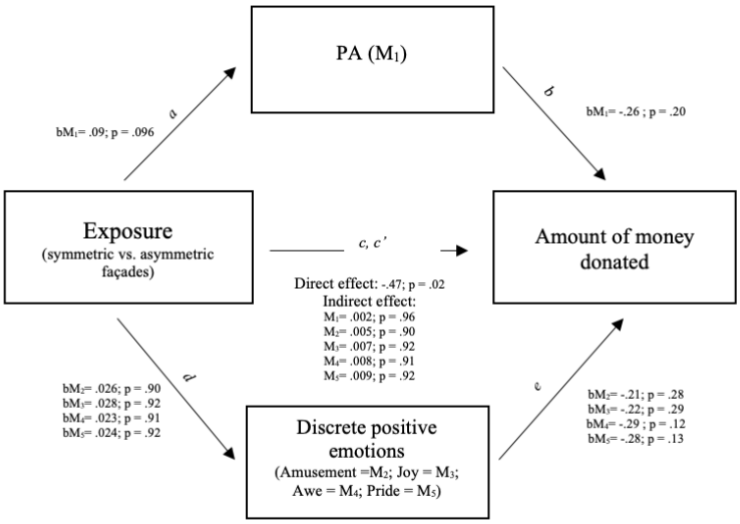


Figure 4: Simple mediation diagram with two mediators; a, b, d, e, c' are path coefficients representing standardized regression weights and p-values. The c' path coefficient represents the direct effect of the exposure to either symmetric or asymmetric façades on the amount of money donated. The c-prime path coefficient refers to the indirect effect of the exposure on the amount of money donated through the mediation of PA and each discrete positive emotion.

3.5.8 Discussion

This study investigates the relationship between aesthetic stimuli and prosocial behavior using the Stimulus-Organism-Response (S-O-R) paradigm, which provides a framework for understanding the interplay between external percepts, internal states, and behavioral responses. We choose to test the impact of architectural symmetric and asymmetric façades (Stimulus) on emotional states (Organism) and, consequently, on the adoption of prosocial behavior (Response). Specifically, in this study, we hypothesized that symmetric façades would promote to a higher extent the adoption of prosocial behavior. We further hypothesize this relationship to be mediated by positive affective states. The discussion is organized to address each hypothesis separately and provide a comprehensive interpretation of the findings.

3.5.8.1 Hypothesis 1: Emotional Responses to Symmetric vs. Asymmetric façades

The findings revealed significant differences in emotional responses elicited by architectural symmetry and asymmetry. Specifically, results indicated a statistically significant difference in negative affect scores between baseline and after exposure to both symmetric and asymmetric façades. Thus, results suggest that the presentation of architectural façades, irrespective of being symmetric or asymmetric, impact participants' negative affect. Interestingly, no significant differences were found in positive affect scores. This implies that while both architectural symmetry and asymmetry reduced negative affect, they may not significantly impact positive emotional states. Further results from the eight discrete emotions are in line with these findings since both sets of architectural façades symmetry led to lower levels of anger and sadness. However, in this case,

significant results were found also for positive emotions. Both types of stimuli, symmetric and asymmetric façades, promoted higher levels of amusement and awe. The lack of significant differences between the symmetric and asymmetric façades regarding NA scores and positive emotions can be explained considering different interpretations. First of all, we are dealing with complex stimuli from a perceptual point of view, and it is possible that the emotions elicited in the individuals might have led to a sort of emotional ambiguity that is difficult to be classified in in discrete labels as measured through self-report questionnaires (Brainerd et al., 2021). Secondly, the situational context in which the building is inserted might have influenced participants' emotional states. Being more specific, the stimuli we selected for the sake of ecological validity, namely, 360° photos of real-life buildings, cannot be taken and be perceived independently from the context in which they are inserted. This context might have impacted participants' affective responses differently via the association with memories participants might have with the context (Barrett et al., 2011).

A further interpretation lies in the intrinsic affective nature of virtual stimuli. For instance, several studies showed that the immersive nature of these scenarios can deeply impact affective responses (Riva et al., 2017; Pavic et al., 2022). In particular, strongly arousing negative emotions have been found to be the type of emotions which are more impacted by immersive VR setups (Juan and Perez, 2009), while positive emotions - i.e., happiness and relaxation appear to be much less influenced by the technology used (Freeman et al., 2005; Baños et al., 2008).

Also, to explain positive affective responses to both types of façades we must consider that our sample was composed by individuals who mainly do not have previous experience with VR technology. Considering this, we could hypothesize that the heightened positive affect responses observed within both sets of stimuli may be due to the so-called "wow effect", linked to the intrinsic capacity of immersive technologies (e.g., Virtual Reality, Augmented Reality, and online videos) to generate awe experiences (Chirico & Yaden, 2018; Pizzolante et al., 2024).

3.5.8.2 Hypothesis 2a and 2b: Prosocial Behavior and the Mediating Role of Positive Affect

Hypotheses 2a and 2b posited that the exposure to architectural façades would directly impact prosocial behavior and that this relationship would be mediated by positive affect (PA) and several ad-hoc positive emotions.

Our findings confirm the direct effect of exposure to different architectural façades on prosocial behavior. Specifically, participants exhibited a higher propensity to donate after viewing symmetric façades compared to asymmetric ones. This result aligns with existing research suggesting that environmental aesthetics can significantly impact human behavior, including generosity (Newman & Bloom, 2012; Van der Vyver & Abrams, 2018). Contrary to our expectations, however, the mediation analysis revealed that neither PA nor the ad hoc positive emotions significantly mediated the relationship between exposure to architectural façades and

prosocial behavior. This suggests that while the aesthetic appeal of symmetry may enhance prosocial behavior, the mechanism driving this effect does not primarily operate through the enhancement of positive affective states. This finding challenges the assumption that positive emotions directly foster prosociality, a premise supported by several theoretical frameworks and empirical studies (Fredrickson, 2001; Isen, 1987).

Several interpretations could be considered for this unexpected outcome. Firstly, it is possible that the prosocial behavior measure, i.e., the Dictator Game, being an economic decision-making task, is not actually suitable to measure prosocial behavior in the context of aesthetic experiences. As such, aesthetic experiences might influence other forms of prosocial behaviors (e.g., social interactions) and not economic decision-making (Grinstein et al., 2019).

Secondly, it could be that the act of donation is mediated by other psychological constructs and/or mechanisms of different nature, not measured in this study (i.e., personal values, social norms, or a more cognitive appraisal of the situation) (Batson et al., 2011; Penner et al., 2005). Following this, architectural symmetry might evoke a sense of order or predictability, thereby enhancing trust and a sense of safety, which in turn could promote generosity (Kaplan, 1992; Keltner & Haidt, 2003). Symmetry has been theorized to be perceived as a manifestation of order and consistency, which are intrinsically linked to ideals of fairness and equilibrium (Arnheim, 1986; McManus & Hastings, 2005).

This distinction is also supported by several architectural theories which suggest that symmetry and asymmetry can be interpreted as representations of varying social and cultural states. Symmetric architectures (i.e., *kouroi* of pre-Classical Greece) reflect a sense of rest and constraint, symbolizing stability and predictability, which can inherently instill a sense of trust in one's environment. Asymmetric architectures (i.e., the fluid and naturalistic forms of the fourth and fifth centuries) are perceived as a disruption of order or predictability, eliciting feelings of uncertainty or disarray (McManus & Hastings, 2005). As a consequence, such a sense of trust, fairness and equity may evoke a sense of moral elevation in individuals, thereby influencing their willingness to engage in prosocial acts (Davoudi & Bell, 2016). This indicates that symmetrical architecture may also evoke a precise cognitive association in individuals, wherein external order and balance trigger an internal response of equity and righteousness, leading to increased engagement in actions that benefit others.

Also, an important aspect of our study that warrants further discussion is the methodology employed to measure emotional responses. Our reliance on self-report measures, though common and valuable for assessing subjective experiences, may not capture the full granularity of aesthetic emotions. These instruments typically assess broader affective states, which may lack the sensitivity to detect ambiguous emotions elicited by architectural aesthetics (that, as stated in the previous paragraph, is context-dependent). Furthermore, beyond self-report measures, incorporating psychophysiological measurements (i.e., electrocardiogram) can offer a more objective and nuanced understanding of emotional responses. Techniques such as heart rate variability, skin conductance, and facial electromyography can provide insights into the autonomic and expressive components of emotional reactions to aesthetic experiences (Bradley et al., 2001; Davidson, 2003).

It is also worth considering the role of individual differences in aesthetic perception and emotional responsiveness. The subjective experience of architecture can vary widely among individuals, potentially moderating the observed effects (Chatterjee, 2014). In this study, we measured trait variables such as openness to positive emotions, appreciation of aesthetic experiences, and empathetic dispositions in our participants. These variables were tested as potential moderators in our model to account for individual differences in aesthetic perception and emotional responsiveness but did not reveal anything.

In conclusion, while our study advances the understanding of how architectural aesthetics can influence prosocial behavior, the findings invite a broader investigation into the underlying mechanisms. The direct impact of symmetry in façades on generosity highlights the potential of environmental design in fostering social cohesion and altruism.

However, the lack of a mediating effect of positive affect highlights the complexity of human behavior and underscores the necessity for further research that considers other mediating factors, measures of emotional states, and trait variables.

3.5.9 Conclusions and Future Directions

Overall, the study's findings, framed within the context of the SOR (Stimulus-Organism-Response) model, offer significant implications for both environmental psychology and practical applications in architectural design. The SOR model posits a comprehensive framework for understanding the intricate interplay between external environmental factors, internal states, and subsequent behavioral responses. In this light, the results of the experiment elucidate the specific ways in which architectural aesthetics could serve as design elements that evoke emotional and cognitive responses, ultimately influencing prosocial behaviors. However, while the SOR model provides a useful overarching structure, its simplicity may overlook some of the nuanced processes that mediate the link between environmental stimuli and behavioral outcomes. This limitation is reflected in the findings of the study, which revealed non-significant results, for instance, regarding the mediating role of emotions. These results suggest that the SOR model alone may not fully capture the complexity of the relationships between perception, affect, and behavior. For example, it does not inherently account for individual differences, top-down cognitive processes, or contextual factors that shape emotional and behavioral responses. To address these potential limitations, it is worth considering alternative frameworks that may offer additional explanatory power. One such model is the Appraisal Tendency Framework (ATF), which could provide a further understanding of the mechanisms underlying the observed findings. The ATF emphasizes the role of specific emotions, shaped by cognitive appraisal processes, in systematically influencing cognition and behavior. Within the context of this study, architectural aesthetics, such as symmetry, may evoke distinct emotional states—like awe, tranquility, or satisfaction—which, as mentioned also in the discussion, are shaped by individual appraisals of features like order or harmony. These emotions, in turn, influence prosocial tendencies and behaviors. By incorporating the ATF, the findings could be interpreted not only as linear

stimulus-response effects, but as outcomes of an interplay between environmental features, subjective appraisals, and resulting emotional states. Future research could explore these appraisal processes in greater depth to clarify how specific architectural features elicit distinct emotional responses and how these responses translate into behavioral outcomes. For instance, integrating frameworks like the ATF alongside the SOR model could help to identify how individual differences or situational contexts influence appraisals and resulting emotions. Additionally, psychophysiological methods could be employed to uncover underlying mechanisms, such as changes in heart rate variability or neural activity, that mediate the connection between architectural aesthetics and emotional responses.

Moreover, the implications of this study extend beyond the realm of aesthetic preferences, with several implications within the domains of well-being and human interaction within designed environments. The observed relationship between architectural symmetry and heightened prosocial behavior underscores the potential of architectural design not only to create visually appealing spaces but also to contribute to the cultivation of positive social interactions and behaviors. Understanding how environmental stimuli prompt emotional and cognitive experiences that translate into prosocial actions can guide architects and designers in curating spaces that foster community engagement, enhance user experiences, and promote healthier and more interconnected social dynamics. Researchers and practitioners can collaborate to develop evidence-based guidelines for creating environments that holistically enhance emotional experiences, social interactions, and overall well-being. The findings also encourage further exploration into the mechanisms that underlie the relationship between perception, affect and behavior. Future research could delve into the psychophysiological processes that mediate the connection between architectural aesthetics and emotional responses.

3.6 Key points of the chapter and conclusions

In this chapter, I delved into the aesthetic dimension of UX, focusing on the role of emotions. This chapter represents the core of the dissertation, as it addresses the novel perspective proposed: considering UX as an aesthetic phenomenon and highlighting the necessity of investigating and designing human-artifact interactions with this in mind.

To establish this perspective, I utilized the framework of User Experience Psychology (UXP) and drew extensively from the literature on aesthetic experience. Contemporary trends in this field increasingly recognize that aesthetic experiences should not be understood solely through perceptual dimensions but must also account for affective, cognitive, and behavioral components. Perception, while crucial, represents only the initial phase of the aesthetic experience. Consequently, aesthetics in UX must be understood as a complex construct that integrates these dimensions, rather than being limited to the superficial appearance of artifacts.

I began by tracing the historical evolution of the psychological analysis of aesthetic experiences. From Freud's early work on the personalities of artists to the emergence of contemporary neuroaesthetics, I provided a comprehensive overview of how the scientific investigation of aesthetics has evolved.

The core of this chapter is further enriched by presenting our first empirical study, which investigates human-artifact interaction specifically within the context of architecture. This study examines the impact of architectural aesthetics on affective states and behavior, demonstrating the practical implications of the theories discussed.

By analyzing how architectural design influences prosocial behavior through aesthetic emotions, this chapter highlights the multidimensional nature of aesthetics in UX. It becomes evident that traditional approaches, which narrowly focus on visual appeal, are insufficient for capturing the variety of user experiences. Instead, aesthetics in UX must be understood as a dynamic and holistic construct, encompassing affective, cognitive and behavioral impact.

By explicitly connecting the findings of the empirical study to this broader perspective, this chapter contributes to the thesis by illustrating how aesthetics in UX can influence not only individual emotional states but also collective behaviors. This connection strengthens the argument that the aesthetic dimension of UX requires an integrative approach, acknowledging its potential to shape user experiences in profound and transformative ways.

This chapter has illustrated that aesthetics in UX must account for a broader range of constructs, integrating affective, cognitive, and behavioral dimensions. The traditional focus on visual appeal is insufficient for capturing the full spectrum of user experiences. Instead, a comprehensive understanding of aesthetic experiences can inform more effective and engaging UX design.

As we transition to the next chapter, I will explore how immersive technologies, particularly Virtual Reality (VR), can be utilized to investigate and enhance aesthetic experiences within UX. This exploration will build on the insights gained from our study of architectural aesthetics, applying them to the context of VR to further understand and harness the transformative potential of aesthetic experiences.

4. Immersive Technology

Extended Reality (XR) encompasses several technologies that expand human sensory perception beyond the physical world, creating a continuum that ranges from complete immersion to the enhancement of the real environment with virtual/digital elements. The three primary technologies under the XR umbrella are Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), each with distinct characteristics and specific applications.

In the subsequent paragraphs, I will only mention the various types of XR, considering the degree of immersivity each technology offers. Immersivity, in this context, refers to the extent to which these technologies can simulate and engage users within a virtual or augmented environment. AR, for instance, enhances the real world with digital overlays, offering a moderate level of immersivity. MR blends real and virtual elements interactively, providing a more integrated immersive experience. VR, however, stands out by offering complete sensory immersion within a fully virtual environment, making it the most immersive of the three.

As such, the chapter will primarily focus on VR, the technology used to conduct all the empirical studies in this thesis. VR's capability to create wholly immersive experiences has been pivotal to this research, offering unparalleled opportunities to investigate and manipulate virtual environments for various experimental purposes, always related to the study of emotional experiences within the aesthetic domain, employing an ecological setting. Initially, I will briefly discuss the historical development leading to the advent of the Head-Mounted Displays (HMDs) currently in use. Following this, I will delineate the rationale for utilizing VR in the context of this thesis, highlighting its potential to create highly immersive experiences with significant emotional engagement. Moreover, I will elucidate the use of VR in the context of User Experience (UX), which represents another crucial reason for its selection in the experimental interventions of this project.

Subsequently, the second experimental study of this thesis will be presented. This study's primary objective was to investigate participants' emotional engagement, sense of presence, immersion, and perceived product quality after exposure to a design product in both virtual and physical environments. Following a brief exploration of VR's role in creating and experiencing "new" aesthetic experiences, the third empirical study will be introduced. This study aimed to test the role of immersion and sense of presence in promoting aesthetic emotions, mainly focusing on aesthetic appreciation and emotional responses.

4.1 Virtual Reality: History and Definitions

Virtual Reality (VR), as we anecdotally know it, can be understood as a technology that allows us to enter another world, often parallel to the real one, a computer-generated scene where one can move and interact, and where immersion is achieved by wearing a special headset. However, firstly, it was not always this way: to reach its current state, VR has undergone a long process of evolution. Secondly, this medium, as progressively

evidenced by psychological research, has, only in recent times, been discovered in its potentiality to extend reality and human capabilities.

In the current and subsequent paragraphs, I will trace the historical evolution and psychological comprehension of VR, as a medium, ideal for designing optimal experiences.

The term “Virtual Reality” (VR) was forged about 40 years ago by the computer scientist and author Jaron Lanier, who relied on Gibson’s idea of *cyberspace*, which was firstly published in his short story “Burning Chrome" (1982). The idea of a Cyberspace became popular with Gibson’s visionary book “Neuromancer” (1984), whose plot described the emergence of a new way to conceptualize human-computer interaction, close to the current one. People and machines were blended to an extent that boundaries between real and virtual dried off. In the real world, this co-existence between virtual and real-life dimensions has achieved one of its maximum levels through Virtual Reality, “a technology that allows physical and virtual spaces to exist in parallel*”* (Gorini et al., 2011; p. 99).

Traditionally, the invention of the first VR system is attributed to a device invented and patented in 1962 by Morton Heilig called the Sensorama. This early VR system, of which only one prototype was produced due to the inability to find financial backing for the project, offered five short experiences simulating a motorcycle ride through the streets of New York. These experiences could be enjoyed by one user at a time, who had to insert their face into a sort of head-mounted display to view the three-dimensional images. The Sensorama was more of a "theatrical experience," yet it contained all the characteristics of modern simulation systems, as it allowed the audience to become more immersed in the representations by artificially stimulating four different sensory channels (sight, hearing, smell, and touch) through stereo displays, fans, odor emitters, and high-frequency stereophonic speakers.

Another pioneer of simulation technology was scientist Ivan Sutherland, who, in 1965, envisioned a display device he called "The Ultimate Display". Using this display, which consisted of two cathode-ray screens mounted on a helmet and connected by cable to the ceiling, individuals found themselves immersed in a virtual world that appeared as real as the physical world in which they lived. Sutherland's idea guided nearly all subsequent developments in the field, introducing three fundamental innovations: stereoscopic vision, head movement tracking through a sensor, and the use of computer-generated interactive images.

However, Sutherland did not stop at just the virtual helmet. In 1968, he built the first true computer-mediated VR system, known as “The Sword of Damocles”. This system, though primitive in terms of graphical realism and comprising a very heavy machine, was a significant milestone in the field of VR, as it introduced the possibility for users to move their heads 360 degrees and still see virtual objects remain "fixed" in the background, just as if they were real-world objects.

Due to the excessive weight of the early prototypes, numerous projects were funded in the 1970s and 1980s to develop more innovative and comfortable VR systems, particularly for training astronauts and pilots of the United States Air Force. This led to the creation of helmets with liquid crystal displays instead of cathode-ray tubes, and the invention of the first virtual suits and gloves.

The evolution of this type of technology continued to progress until the 1990s, when it also became part of popular culture, especially thanks to popular movies such as The Matrix (1999). However, commercial interest waned during this period, primarily due to the high costs of the systems and the low quality of the virtual experience that these still rudimentary systems offered.

In more recent times, however, there has been a resurgence of interest in VR, primarily linked to the world of video games and general entertainment. Major technology players, starting from the first decade of the 2000s, have realized the potential of this technology as a new experiential medium, capable of replacing the television screen as the dominant communication medium, and allowing users to enjoy and interact with video content, even on mobile devices and smartphones (consider, for example, Google's Cardboard). The main protagonists of this new evolution were primarily Oculus VR (acquired by Facebook in the spring of 2014) with its Oculus Rift headset for PC, Google with its Cardboard, a cardboard box with lenses similar to those of Oculus associated with a smartphone running a dedicated application, HTC Vive (a collaboration between HTC and the video game company Valve) with the VIVE headset, a wireless device that allows advanced forms of interaction such as eye movement tracking. Initially designed for gaming, today Oculus headsets are used by everyone, both technical and non-technical users, in various fields: from medicine to education, from industry to marketing, and in entertainment, in the form of video games, theater performances, films or the creation of new type of aesthetic or art experiences (I will delve deeper into the potential of VR for art and aesthetic in the paragraph 4.5 of this chapter).

In other words, the development of new media and technologies for representing and designing human experiences has accompanied our entire history in an evolutionary path where VR is an important but not definitive milestone. Currently, there are various types of technological systems, immersive and/or engaging, that allow us to relate to our physical reality, everyday life, objects, and other people in entirely new ways.

Nowdays, our reality and interactions are increasingly taking the form of "mixed" experiences, halfway between what is "real" and what is "virtual." The progressive integration of devices and technological systems into our daily environments has gradually led us towards the development of so-called "Mixed Reality" (Riva & Gaggioli, 2019). Consider, for instance, the potential of one of the latest headsets on the market, the Apple Vision Pro, which exemplifies the advancements and capabilities inherent in Mixed Reality technology.

The term "Mixed Reality" refers to a "hybrid physical-digital ecosystem characterized by the continuous and bidirectional exchange of data and information between the real and virtual worlds, where actions performed in the former will influence the latter and vice versa" (Speicher et al., 2019). This term also encompasses a spectrum of technologies ranging from real to virtual environments, passing through various degrees of "virtuality," outlining what has been called the "Reality-Virtuality continuum" (**Figure 5**) (Milgram et al., 1994). The poles of this continuum are the Real and a complete Virtual Environment.

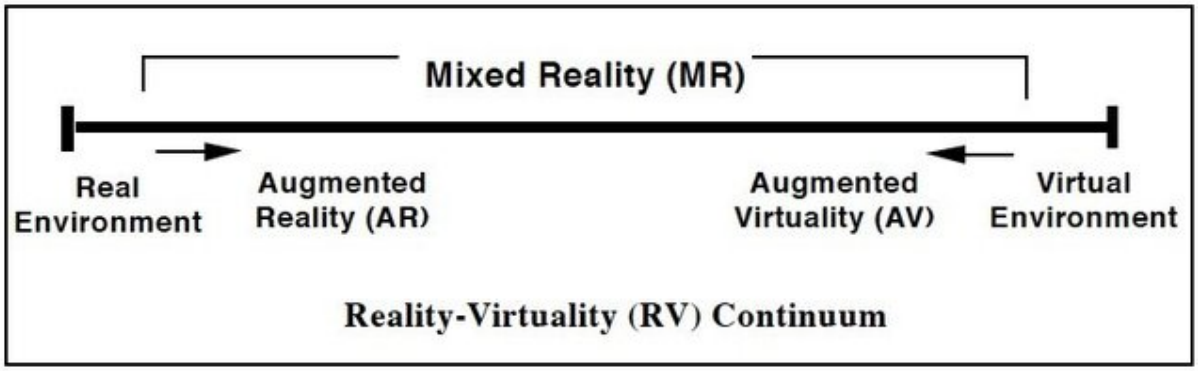


Figure 5: Reality-Virtuality Continuum (Milgram, Takemura, Utsumi, & Kishino, 1994).

As for VR, its definition and characteristics will be discussed in the following paragraph. Augmented reality (AR), on the other hand, refers to a scenario in which virtual objects are superimposed onto reality, or more precisely, "layers" are overlaid on the physical environment surrounding the user, thus adding something to the real context in which they are situated - hence the term augmented. Possible examples are the video game Pokemon GO (2016) and Google Glass, a see-through visor that allows the user to perceive the surrounding space by observing it through transparent screens onto which virtual content is projected.

It can therefore be said that our reality is increasingly "mixed," as the real world has been enriched over time with virtual systems, technologies, and objects. Rather than viewing the spread of new technologies as a threat, this "virtualization" should be viewed as an opportunity to improve human experiences. This is, broadly speaking, the objective pursued with all the studies included in the current thesis.

4.2 VR for promoting complex emotional experiences

Since 1989, when Jaron Lanier first used the term, VR has been described as a computer-simulated three-dimensional environment in which people are immersed and with which they can interact (Riva & Gaggioli, 2019). According to a more recent definition, VR consists in a synthetic 3-D world (Virtual environment – VE) generated from numerical data elaborated by a computer. Users can navigate this environment and interact with objects present inside it (Burdea & Coiffet, 2003; Wohlgenannt et al., 2020). Additionally, they can feel as if they were an authentic part of this simulated environment by means of a multisensory integrated stimulation (i.e., visual, aural or haptic). People can interact with this environment by exploring it either in an active (i.e., choosing the direction or the speed etc. of their moments inside the VE) or passive way (i.e., being “transported” within the environment, without controlling direction or speed). Further, users can also manipulate simulated objects and use them to accomplish their goals within the VE. Crucially, they can interact with other people, by means of avatars, i.e., virtual representations of other people (Fox & Ahn, 2013; Gaggioli, Mantovani,

Castelnuovo, Wiederhold, & Riva, 2003; Trepte & Reinecke, 2010; Trepte, Reinecke, & Behr, 2009; Triberti & Chirico, 2016; Triberti, Durosini, Aschieri, Villani, & Riva, 2017; Vasalou & Joinson, 2009).

From a more technical perspective, however, a VR system requires a series of components to function: a computer powerful and efficient enough to process complex data from the user in real time, update and modify the continuous flow of images, and synchronize it with the user's movements; the virtual environment, i.e., software that generates an interactive three-dimensional model of a real environment; input peripherals, which detect the user's reactions and movements, and output (or display) devices, which vary depending on the type of sensory channel being stimulated (Ryan, 2015). Thanks to dedicated output peripherals, such as headphones or virtual gloves, it is possible to exploit different sensory modes, such as hearing and touch, in addition to visual stimuli, which remain the dominant stimulation channel in modern VR systems.

Beyond the technical characteristics, VR systems can be defined based on their immersiveness, or the degree to which the user experiences the simulated virtual environment from a first-person perspective, as well as the level of sensory isolation from the surrounding environment and the sophistication of the simulation (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015). Based on the degree of immersiveness, VR systems can be divided into at least three types of VR devices (Bamodu and Ye, 2013): non-immersive VR (NIVR), semi-immersive VR (SIVR), and immersive VR (IVR). In NIVR, the user is interacting with a computer or console via mouse, keyboard, or gamepad/joystick input. The user is aware of the real world without being fully immersed in the virtual environment (VE) (Shahrbanian et al., 2012). With SIVR, the VE is projected onto a large screen and the user interacts with the VE using advanced interface devices such as cybergloves, haptic feedback devices or infrared cameras, while simultaneously being able to perceive the real world as well. In an IVR system, users interact with the VE using a head-mounted display (HMD) and a 3D input device (VR controller or data gloves). The user is fully immersed in the VE with which they can interact, a feature that distinguishes this technology from the others (Shahrbanian et al., 2012).

Another important characteristic of VR systems is interactivity, a term indicating the user's ability to exert at least partial control over the simulated environment, which varies based on body movements, adapting and responding dynamically to the actions performed by the subject in both the real and virtual worlds (Riva & Gaggioli, 2019).

Together, immersiveness and interactivity contribute to developing the key characteristic of VR systems, which is fundamental for making the user's experience in the simulated world as similar as possible to their experience in the real world: the sense of presence. Simply put, feeling truly present is the illusion of being in a specific place in a specific moment ("being there") "along with the perception of being able to fulfill our intention within that" (Riva, 2009; Riva, Waterworth, & Murray, 2014). However, this phenomenon is believed to be at the base of our awareness of the word, of ourselves and other people (Riva & Waterworth, 2014; Riva, Waterworth, & Waterworth, 2004; Riva, Waterworth, Waterworth, & Mantovani, 2011; Waterworth & Riva, 2014; Waterworth, Waterworth, Mantovani, & Riva, 2010; Waterworth, Waterworth, Riva, & Mantovani, 2015)

From early conceptualizations of presence related to the technological domain (e.g., Lombard & Ditton, 1997; Lombard & Jones, 2015; Sheridan, 1992), sense of presence has evolved, and several scholars now conceive it as a psychological phenomenon and not necessarily the medium's features (Riva, Mantovani, Waterworth, & Waterworth, 2015). With this regard, although presence is not just a function of media, most authors (e.g., Baños et al., 2004; Freeman, Lessiter, Pugh, & Keogh, 2005; Lessiter, Freeman, Keogh, & Davidoff, 2001; Riva, Davide, & IJsselsteijn, 2003; Steuer, 1992) agree that it can be manipulated by means of some features typical of these technologies, such as *media content* and *media form*.

As for media form, subject experiences the illusion of non-mediation not only when the simulation is graphically realistic and adherent to reality (e.g., pictorial realism) but also when it allows effective and intuitive interaction with the surrounding environment, enabling the already mentioned concepts of immersion and interactivity.

To better understand this concept and grasp what a subject truly experiences during a VR system session, it may be useful to refer to the theory developed by Riva and Mantovani (2012), which explains, by identifying two types of interactions with technology, why one feels present within a VR environment: the subject does not merely use a medium but incorporates and embodies it. According to the authors, when engaging in a virtual experience, indirect mediated action occurs subject use their body to directly control a tool, such as the controllers (proximal artifact), which allows them to control a second tool situated within the virtual environment, like their avatar (distal artifact), to realize their intentions and achieve their goals in the virtual world. In summary, when a subject experiences simulation that allow controlling a distal artifact through intuitive use of a proximal artifact, they become embodied in the space where the avatar is located, experiencing the sensation of being truly present in the virtual environment.

It is the potential of this technology that allows the user to become a protagonist in an experience rather than just a passive observer. The user becomes an active subject who can modify the content of their experience through the choices and actions they make in real-time.

Regarding media content variables, authors conceptualized "content" as both visual and oral narratives. Preliminary studies demonstrated that narratives (Gorini et al., 2011), as well as emotional contents (Baños et al., 2004; Baños et al., 2008; Baños et al., 2006), can enhance the sense of presence related to a VR environment. Thus, another assumption could be made, that VR could enhance emotional intensity and could represent an ideal *affective* medium.

4.3 The potential of VR for emotion induction

There are different methods apt to induce emotions, including (but not limited to) the use of film clips, where participants are shown short validated video segments that elicit specific emotions (Gross & Levenson, 1995) or the presentation of emotionally charged images, often sourced from standardized databases such as the International Affective Picture System (IAPS) (Lang et al., 1997). Autobiographical recall is another powerful technique, where individuals are asked to recall and describe personal experiences that elicited strong emotions

(Strack, Schwarz, & Gschneidinger, 1985). Music is also frequently used to induce emotions, with certain pieces or genres selected to evoke specific feelings (Juslin & Västfjäll, 2008).

In addition to utilizing various naturalistic materials, virtual reality (VR) techniques are also emerging in the fields of cognitive and affective science. Previous studies have revealed that VR elicits emotions more efficiently than the classical methods (Baños et al., 2006; Riva et al., 2007)

A recent review by Somarathna et al., (2022) highlighted how VR stands out as an ideal medium to elicit emotions through an active method in an ecological and controlled environment.

However, the effectiveness of VR as an affective medium could depend upon different factors.

Firstly, it could be related to fluctuations in the level of presence which, as I have outlined, could depend upon several features related to the media form (i.e., immersion, interactivity, and pictorial realism) (Diemer et al., 2015; Parsons, 2015; Parsons & Rizzo, 2008). For instance, earlier empirical studies have shown that higher levels of presence in VR environments are significantly associated with increased emotional responses. Diemer et al. (2015) demonstrated that participants who reported higher presence in a VR setting also exhibited stronger emotional reactions, suggesting a direct correlation between presence and emotional intensity. Research by Riva et al. (2007) explored the emotional impact of different virtual environments designed to evoke specific emotions such as anxiety, relaxation, and neutrality. These environments were displayed through head-mounted devices (HMDs) capable of tracking head movements. The study found that manipulating environmental components like music, lighting, and textures could effectively induce the intended emotional states. Crucially, higher levels of presence were associated with more intense emotional states, indicating that presence can be significantly influenced by VR features.

Baños et al. (2004) further investigated the role of immersion by exposing participants to virtual environments with varying levels of technological immersion (e.g., head-mounted displays, video walls, and PC monitors). Their findings revealed that while higher technological immersion often enhances presence, the emotional content of the environment also plays a crucial role. For instance, participants exposed to a sad virtual environment via a highly immersive setup did not necessarily report higher presence compared to those using less immersive setups. This suggests that the effectiveness of VR in inducing emotional responses is not solely dependent on the level of technological immersion but also on the congruence between the immersive environment and the intended emotional content. Moreover, Baños et al. (2008) confirmed that increased immersion does not always equate to heightened emotional intensity or presence. Their study showed that stereoscopic presentation, while more immersive, did not always lead to stronger emotional responses or a greater sense of presence. This highlights the importance of carefully calibrating VR environments to match the target emotional states, as different emotions may respond differently to variations in technological sophistication.

Secondly, the type of emotion induced could be decisive.

Earlier research has employed VR as a medium to induce and analyze emotions based on the discrete emotion theory, which posits the existence of several core emotions, each eliciting a specific response to address an evolutionary need (Baños et al., 2009). For instance, Felnhofer et al. (2015) successfully elicited emotions such

as joy, sadness, anger, anxiety, and boredom by immersing participants in five distinct virtual park scenarios. Similarly, Meuleman and Rudrauf (2018) used VR games to evoke a broad spectrum of discrete emotions. Thus, it is evident that VR is particularly effective in eliciting a range of emotional responses, categorized broadly into positive, negative, and complex ones. Positive emotions such as joy, happiness, and surprise are often elicited through VR experiences. However, VR especially benefits negative emotion elicitation, since negative emotions are difficult to induce in standard laboratory settings.

Negative emotions, including sadness, anger, and anxiety, are effectively induced through VR (Anderson et al., 2013). In particular, strongly arousing negative emotions have been found to be the type of emotions which are more impacted by immersive VR setups (Juan and Perez, 2009), while positive emotions - i.e., happiness and relaxation appear to be much less influenced by the technology used (Freeman et al., 2005; Baños et al., 2008). Complex emotions, such as awe and nostalgia, have also been shown to be effectively induced through VREs. Experiences designed to elicit awe, for instance, might involve vast, breathtaking landscapes, or detailed simulations of space or deep-sea environments (Chirico et al., 2018).

Lastly, VR's effectiveness could depend upon the content utilized to elicit these emotional responses. VEs, where users interact with virtual entities, offer a high level of engagement and presence. In contrast, 360-degree videos expose users to panoramic video clips, allowing them to experience a scene as if they were physically present. Interactive games require active user participation, often leading to strong emotional and physiological responses. Structured tasks involve users performing specific interactive activities designed to elicit emotional reactions. Avatars, which are graphical representations of people that users can interact with, are frequently used to study social and emotional responses. Although less immersive, static images can still evoke strong emotional reactions, particularly when they are vivid or personally relevant. Additionally, 360-degree panoramas provide a three-dimensional view of a scene, enhancing the sense of presence and immersion. Multi-modal content, which combines several types of media (e.g., interactive tasks within a 360-degree video environment), is also employed to maximize the emotional impact.

4.4 VR for User Experience

As previously discussed, UX research and design predominantly focused on evaluating dimensions related to usability and task-oriented values. However, recent trends advocate for the inclusion of users' emotional needs in the design process, highlighting the role of human factors (Khalid, 2006). As we have seen, while many usability approaches often overlook the impact of emotions, the aesthetic appeal of a product, along with the pleasure and satisfaction it provides to users, is crucial for its market success (Khalid & Helander, 2006).

Firstly, the analysis of such responses relies heavily on the realistic representation of the artifact within its usage context.

Secondly, most traditional tools for assessing UX rely on retrospective, subjective measures, such as questionnaires and self-reports. These methods typically capture users' emotions, reactions to the product's appearance, and sensory experiences after they have interacted with the product, rather than during the

interaction itself. As a result, these tools often fail to provide a comprehensive picture of the user experience over time.

Moreover, subjective measures are inherently limited by the user's ability to accurately recall and articulate their experiences. This can lead to biases and inaccuracies, as users may forget specific details or be influenced by their current mood or external factors. Additionally, these methods only assess the sensory experience after static exposure to a product, neglecting the dynamic and evolving nature of user interaction (Rebelo, 2012).

VR could help overcome traditional design and evaluation challenges by replicating artifacts and real-life contexts of use, allowing for controlled and consistent experimental conditions.

This begins with creating a virtual prototype of the artifact to be evaluated, along with replicating a real-life environment where all UX core dimensions can be tested.

Traditionally, physical prototypes and Computer-Aided Design (CAD) software have been used by designers for concept presentation (Park, Im, & Kim, 2018). Physical prototyping involves developing a partially or fully functional product, but this method can be costly, does not allow for evaluating the artifact in its context of use, and cannot reproduce the specific behavior of a product (Bordegoni & Ferrise, 2013). CAD software allows for the creation of digital prototypes, but these are not easily evaluable by users in a realistic manner. Users often find it challenging to fully understand and assess the usability, ergonomics, and overall experience of a product through digital models alone, as these models lack the interactive and immersive qualities that physical prototypes or VR environments can provide.

Virtual Prototyping (VP) method, which involves three-dimensional (3D) digital models, overcomes these limitations. VP can be used before and during the product development process to ensure alignment between the product concept and final user needs, with the goal of preempting issues before the product is actually realized.

From a UX research perspective, this approach allows the creation of virtual prototypes of objects that do not yet exist, enabling researchers to study user reactions and gather feedback even before the actual creation of these objects. This procedure can evaluate, through specific tests, the degree of acceptance of the product by the user (Bordegoni & Rizzi, 2011).

On the UX design side, when the prototype is already created, this approach allows for the experimentation and validation of new products with potential consumers at the earliest stages of the design process in their natural usage context, thereby minimizing the risk of developing products that, while functionally adequate, fail to meet user experience expectations (Bordegoni et al., 2014; Bordegoni, 2023). Furthermore, VR technology provides a high degree of ecological validity while maintaining the necessary experimental control, thus enabling more accurate and reliable assessments of user interactions within realistic contexts. Thus, it facilitates the creation of interactive environments where tests with customers can be conducted to validate the most crucial ergonomic but most important, aesthetic and affective features of the final design product, and to explore new potential alternatives (Carulli et al., 2013).

To conduct these tests - which was the second big challenge posited at the beginning of the paragraph - real-time measurement tools such as biometric sensors and eye-tracking devices, can provide continuous, objective

data on user reactions throughout the interaction. These tools can monitor physiological responses, such as heart rate, skin conductance, and facial expressions, offering insights into the user's emotional state as they engage with the product.

Furthermore, VR environments can be equipped with motion capture systems to track user movements and behaviors, providing a detailed analysis of how users physically interact with the product. This data can reveal patterns and preferences that are not easily captured through retrospective measures.

In addition to biometric and behavioral data, integrating machine learning algorithms can enhance the analysis of user reactions. These algorithms can identify subtle patterns and correlations in the data, offering deeper insights into the factors that influence user experience. For example, machine learning models can predict user satisfaction based on a combination of physiological and behavioral indicators, providing a more holistic understanding of the user experience.

In the previous paragraph, I outlined the main dimensions conveyed by VR, focusing on immersion, sense of presence and interactivity. These core elements are essential for fostering participant engagement in virtual environments (VE). Now, I will contextualize these dimensions within the broader scope of UX, incorporating additional factors that influence the effectiveness and overall impact of VR technology.

As suggested by Burdea and Coiffet (2003), ensuring participant engagement in VR requires three key features: interaction, immersion, and imagination, collectively known as the “VR triangle”. These elements are interconnected and essential for creating a comprehensive UX.

To better contextualize these dimensions within the user experience framework, we need to explore how each element of the VR triangle impacts and enhances the overall UX.

- Interaction, which mirrors the previous concept of “interactivity,” refers to the dynamic communication between the user and the VR system. This involves detecting user motions and actions and updating the virtual environment (VE) accordingly (Rebelo et al., 2012). In the realm of UX, real-time interactivity can be achieved through devices like motion trackers and sensing gloves. These devices allow natural gesture-based interactions by measuring the position and movements of the user's hands and fingers. However, challenges such as the lack of tactile feedback and the need for specific calibration for different users can affect the quality of interaction. Advanced gloves with force feedback mechanisms provide a more realistic sensation of touching and manipulating virtual objects, enhancing the user's experience.
- Immersion relates to the sensation of being inside the VE, primarily influenced by what the user sees and hears. Different levels of immersion can be achieved through various VR interfaces: fully immersive (head-mounted displays or HMDs), semi-immersive (large projection screens or CAVEs), and non-immersive (desktop-based VR). HMDs, for example, visually isolate the user from the real world, enhancing the feeling of immersion, though they can be limited by field of view, image resolution, and comfort issues. Sound also plays a crucial role in immersion by providing realistic audio cues that must be synchronized with VE events to be effective. In the UX context, achieving a high level of immersion can significantly enhance user satisfaction and engagement with the product.

- Presence, a key strength of using VR for product testing, is a dimension closely related to immersion. It refers to the user's psychological state of being in the VE. This sense of presence occurs when the brain processes multimodal stimuli (visual, auditory, etc.) as a coherent environment where the user can act and interact. Presence is critical for a successful VR experience and is influenced by both involvement (the user's concentration on the VE) and immersion. Distractions can negatively impact the user's sense of presence, reducing their overall experience. In UX research, inducing a strong sense of presence can provide valuable insights into how users might interact with a product in real-world scenarios.
- Imagination involves the user's ability to perceive and believe in the VE, even while knowing they are physically elsewhere. This is influenced by the levels of interactivity and immersion, as well as the realism of the VE, the tasks performed, and the user's motivation. A higher degree of realism and well-designed tasks can significantly enhance the user's imaginative engagement. In the context of UX, fostering imagination allows users to fully explore and interact with virtual prototypes, providing feedback that can be crucial for product development.

From a research perspective, VR represents the new frontier of UX design due to its ability to realistically replicate objects and scenarios that may not yet exist. This capability allows researchers to evaluate and manipulate these virtual prototypes and measure user reactions in real-time using various tools and methods. VR's potential to create and test hypothetical situations provides invaluable data that can significantly inform and improve the design process.

In sum, when compared with conventional processes, VR has many advantages for the evaluation of UX. Most of VR’s limitations and drawbacks are associated with the current technology available. Although VR technology is developing rapidly, its progress may be hampered by the side effects experienced by participants, which raises concerns regarding their health and safety as well as VR’s overall effectiveness.

4.5 Study 2: Virtual vs. Real: Exploring Perceptual, Cognitive and Affective Dimension in Design Product Experiences

This paper has been published in BMC Psychology (2024).

Pizzolante, M., Bartolotta, S., Sarcinella, E.D. *et al.* Virtual vs. real: exploring perceptual, cognitive and affective dimensions in design product experiences. *BMC Psychol* 12, 10 (2024).

* All references for this study have been compiled and are available in Appendix 1.

4.5.1 Abstract

Background: Virtual Reality (VR) has already emerged as an effective instrument for simulating realistic interactions, across various domains. In the field of User Experience (UX), VR has been used to create prototypes of real-world products. Here, the question is to what extent the users' experience of a virtual prototype can be equivalent to that of its real counterpart (the real product). This issue particularly concerns the perceptual, cognitive and affective dimensions of users' experiences.

Methods: This exploratory study aims to address this issue by comparing the users' experience of a well-known product, i.e., the *Graziella* bicycle, presented either in *Sumerian* or *Sansar VR* platform, or in a physical setting. Participants' Emotional Engagement, Sense of Presence, Immersion, and Perceived Product Quality were evaluated after being exposed to the product in all conditions (i.e., *Sumerian*, *Sansar* and Physical).

Results: The findings indicated significantly higher levels of Engagement and Positive Affect in the virtual experiences when compared to their real-world counterparts. Additionally, the sole notable distinction among the VR platforms was observed in terms of Realism.

Conclusions: This study suggests the feasibility and potential of immersive VR environments as UX evaluation tools and underscores their effectiveness in replicating genuine real-world experiences.

4.5.2 Background

VR offers promising advantages for simulating and assessing the dynamics of real-world interactions. VR technology allows individuals to be immersed in lifelike scenarios, situations, and contexts that closely resemble the corresponding real ones. However, VR also offers the possibility of simulating impossible worlds or unusual situations, promoting novel and unique experiences – i.e., liminal experiences [1,2] self-transcendent [3] and out-of-the-body experiences [4,5] which can lead to an altered perception of the self or to heightened affective and cognitive responses.

In recent times, thanks to the rapid widespread adoption of immersive technologies and software development, VR has gained popularity in the domain of User Experience (UX) for both research and design purposes. [6,7]

Firstly, VR allows researchers to create ecological immersive environments in which they assess individuals' reactions and interactions towards products, and/ or services. [8,9,10,11] This, in turn, leads researchers to evaluate the final user while interacting with a product/service in its natural usage context, which is something not always

possible in real life. Additionally, VR technology allows the collection of multiple information in the same session (e.g., psychophysiological measures, movement tracking, self-report measures, etc.), which, in turn, can lead to a deeper understanding of the individual's perception, cognition and affect in response to the product/ service.

Secondly, UX designers can use VR to create and modify three-dimensional (3D) digital versions of physical prototypes, that is, Virtual Prototyping (VP). [12,13,14,15]

For example, using VR, designers can simulate a prototype of a car, including its exterior and interior. They replicate user interactions with controls, testing different environmental factors like road surfaces and weather conditions to assess their impact on the vehicle's performance, safety, and overall user experience.

Therefore, VP brings numerous advantages by enabling real-time changes to 3D virtual models based on user feedback. This empowers architects and designers to make informed design decisions that prioritize user participation and functionality reducing time-to-market, cost savings, and knowledge sharing. [16]

VR is an exceptionally versatile instrument for evoking unique characteristics that can significantly impact the user's experience during interactions with the service or product. Various concepts are associated with virtual experiences, encompassing both device characteristics and the psychological states that arise from taking part in these experiences. For the purposes of this study, we will specifically concentrate on and, consequently, differentiate between the concepts of immersion and sense of presence.

According to the conceptualization introduced by Slater and Wilbur in 1997[17], *immersion* is fundamentally a perceptual phenomenon. It relies on the objective technological capabilities of the device to provide a varied array of multisensory stimulation and tracking that maintain fidelity to real-world sensory modalities. The greater the fidelity achieved, the more the experience can be described as "immersive".[18] Today, immersive technologies can deliver multisensory immersive experiences, by stimulating all the exteroceptive senses. [19]

Tied to the concept of immersion, VR has been found to sustain the sense of presence, defined as the psychological sensation of really being within the virtual environment. [17] The sense of presence stands out as a key outcome in virtual experiences and has been employed in scholarly works as a metric for assessing the user experience.[20] It has been shown that the greater the sense of presence, the higher the capability to locate the self in the environment or situation, based on the perceived possibility to act in it. [21,22] Research shows that sense of presence is also influenced by many factors including sensor fidelity, high-quality graphics, interactivity, and social presence. [23,24,25,26]

Finally, VR has shown efficacy in eliciting emotionally resonant experiences - intense emotional responses, closely mirroring [27,28,29] or intensifying the feelings typically associated with real-world stimuli or events [30,31] - evoking both simple emotions such as fear and joy [32] and complex emotions such as awe and interest, [33,34] which, in turn, heighten the user's sense of presence and immersion. [35,36]

Only a few studies have been conducted to compare UX of the same product/service in virtual vs. real settings. [37,38,39,40] Nevertheless, some of these studies have tangentially investigated how these features – namely immersion, sense of presence and emotional responses – differ between virtual and real products' evaluations. This incidental examination emerged not from a direct intent to probe the depths of virtual versus real subjective

experiences, but rather as a secondary consideration within research primarily centered on human-product interaction (i.e., ergonomics aspects, usability). Furthermore, these investigations have led to inconclusive results.

For instance, Kuliga et al.[38] reported similar levels of spatial presence and emotional engagement when comparing a virtual building to a real one. A study by Westerdahl et al. [37] showed that the virtual representation of an architectural model of a building was appreciated by participants since it gave veridical information about how the real building was perceived. However, users also acknowledged that the virtual model lacked sensory qualities and did not fulfill all the conventional criteria for providing a high degree of presence.

Furthermore, to our best knowledge, only one study [41] examined the relationships between presence, usability and user experience in a navigation task on a mobile app performed in a Cave Automatic Virtual Environment and in real life. The results showed a positive connection between the virtual field environment and hedonic qualities of the mobile app and confirmed the effect of usability on perceived presence. [41] To maximize the potential of VR as a valuable tool for UX research and design, it is essential to conduct more thorough studies that specifically explore the perceptual, cognitive, and emotional differences between virtual and real product interactions. In response to this need, the current exploratory study aimed to compare participants' experiences—evaluating perceptual, cognitive, and emotional responses—when observing a design product, namely the Graziella bicycle, in virtual versus physical settings. This involved examining immersion, sense of presence and emotional engagement to understand how virtual experiences differ from their physical counterparts.

4.5.3 Methods

This exploratory study employed two specific virtual platforms: *Sumerian*, designed by *Amazon*[1] and *Sansar*, developed by *Linden Lab.*[2] (**Figure 6**)

The selection of the two platforms was informed by several reasons.

Compared to other game engine apps (e.g., *Unity, Unreal Engine*), both platforms are designed to be more accessible to non-developers (i.e., designers), allowing users to create VR experiences without extensive programming skills. However, they also present distinct features.

Sumerian, an *Amazon Web Services (AWS) product*, is recognized for its ease of use and rapid implementation. Thus, it enables quick prototyping and iterative design, important aspects for UX studies. Sansar, developed by *Linden Lab*, offers higher advanced graphics and dynamic lighting effects. Its enhanced visual capabilities, including detailed texture rendering, make it an optimal choice for studies focusing on the perceptual aspects of virtual experiences.

By evaluating the same product in both environments, we aimed to discern how these platforms differently influence users' perceptual, cognitive, and emotional experiences. The unique attributes of each platform - Sumerian's user-friendly design and Sansar's focus on high-fidelity graphics - provided a comprehensive framework for understanding the potential of VR in UX design.

Consequently, the specific goals of the current study are as follows:

1. To compare the "real" and "virtual" experiences of the same design product by investigating several dimensions including immersion, sense of presence, emotional engagement, and perceived quality of the product.

2. To compare the two virtual experiences by means of Sumerian and Sansar platforms while evaluating the same dimensions mentioned above. The primary aim of this analysis is to identify the main strengths and weaknesses of each platform within a potential design application context.

Ultimately, this exploratory study aims to assess whether immersive virtual product presentation can function as an efficacious alternative or supplementary approach to physical product presentation in the realm of UX application.

Figure 6: Above the Sumerian Virtual Environment; Below the Sansar Virtual Environment.

4.5.3.1 Participants

A total of 62 participants took part in the study (M_{age} = 36.10, SD_{age} = 21.12).

Participants were recruited through a convenience sampling method, primarily targeting individuals with prior experience in VR to ensure familiarity with the technology used in the study. This approach was chosen due to its efficiency and the ease of accessing participants within our network who met the study's requirements.

Inclusion criteria required participants to be over 18 years old and to possess prior experience with VR. Also, exclusion criteria included history of severe motion sickness or vestibular disorders, uncontrolled epilepsy or

seizures triggered by visual stimuli, pre-existing visual impairments that could be exacerbated by VR, claustrophobia or anxiety triggered by enclosed environments.

The participants were divided into three groups for the study conditions:

1. For the Sumerian platform (CSum), 21 subjects were recruited, comprising 14 females and 7 males (Mage = 44.05, SDage = 21.12).
2. For the Sansar platform (CSans), 21 subjects were recruited, comprising 11 females and 10 males (Mage = 39.29, SDage = 17.10).
3. For the physical presentation of the bicycle (CPhys), 20 subjects were recruited, of which 8 were females and 12 males (Mage = 36.10, SDage = 15.84).

4.5.3.2 Tools

As described before, the design product, the *Graziella* bicycle, was presented either to participants as a virtual version on the *Sumerian* (CSum) or the *Sansar* (CSans) VR platform, or in physical presence (CPhys) in the main meeting room of a design studio in Italy. Participants belonging to the virtual conditions observed the virtual version of the product through an *HTC Vive Pro* Head Mounted Display (HMD), which included wireless controllers and two sensors for tracking and mapping users' movements in the virtual environment.

4.5.4 Procedure

A *between-subjects* study design was employed with participants randomly assigned to one of the three conditions. All participants signed an informed consent prior to the session, ensuring anonymity through ID codes, and completed a pre-exposure questionnaire.

For virtual product experience conditions (CSum, CSans), participants were informed that they would be immersed in a virtual environment simulating the main meeting room of the design studio. They could move using wireless controllers and were instructed to observe the bicycle, avoiding interaction, and focusing solely on its visual qualities. For the physical presentation of the product (CPhys), participants could freely move inside the main meeting room of the studio to observe the *Graziella* bicycle, without interacting with it.

Also in this condition, participants were invited to focus on the visual characteristics of the product. The duration of each session was predetermined and fixed at approximately 10 minutes for all conditions. This timeframe was selected to balance adequate participant engagement with the product while minimizing potential fatigue, especially in the VR conditions. At the end of this fixed period, the experimenter indicated that the session had concluded and asked the participant to remove the HMD and to complete the post-exposure questionnaire.

4.5.5 Measures

Before the experimental session, participants completed a pre-exposure questionnaire which included demographic information such as gender, age, qualifications, place of residence, occupation, previous VR experiences.

At the conclusion of the experimental session all participants in each condition filled out a post exposure questionnaire which included three different scales for CSum and CSans and all the scales apart from the *Objects Presence Questionnaire* (OPQ) for CPhys.

- The *ITC - Sense of Presence Inventory* (ITC-SOPI),[44] in its Italian adaptation, evaluated participants' degree of immersion and presence and engagement within the virtual or the physical environment. It measures four different dimensions: *Sense of Physical Space, Engagement, Ecological Validity* and *Negative Effects*. Lessiter et al. [44] defined each group as such:

– *Sense of Physical Space:* sense of physical space in environment, interaction with and control over the parts of the environment;

– *Engagement:* sense of being psychologically immersed and enjoying the content presented;

–*Ecological Validity:* sense that the environment is lifelike real and resemble a real context/situation;

– *Negative Effects:* sense of adverse physiological reactions to the environment presented.

Participants rated each item on a 5-steps Likert scale (from 1= totally disagree to 5= totally agree). This subscale aims at identifying adverse physiological reactions that participants might experience with immersive technology, such as cybersickness.

Items in some of these subscales (i.e., *Sense of Physical Space* and *Ecological Validity*) were adapted to specifically refer to the physical environment in which the experience occurred, following guidelines by Usoh et al.[42] and Nisenfeld.[43]

- The *Objects Presence Questionnaire* (OPQ),[45] in its Italian adaptation, was used to capture the extent to which participants felt engaged with the elements within the simulated environment. Given the aim of this scale, results of the OPQ have been analyzed only between CSum and CSans conditions. The OPQ includes three different subscales: the *Involvement,* the *Realism* and the *Quality of Interface* (QoI) subscales.

- The *Quality of Interface* dimension measures the perception of product quality and usability. It indicates how positively the user assesses the ease of use, clarity, and effectiveness of the product;
- The *Realism* dimension assesses how much an individual perceives the product realistic in its usage context;
- The *Involvement* dimension measures how much participants are absorbed by the experience and responsiveness of the application.

- The 20-item *Positive and Negative Affect Schedule* (PANAS) questionnaire, [46] in its Italian validated version[47] was used to evaluate the emotional state of the participants at the baseline and after each experience. The scale comprises a *Positive Affect* (PA) subscale, assessing positive feelings or emotions such as joy, enthusiasm, satisfaction, and energy and a *Negative Affect* (NA) one evaluating negative feelings or emotions such as sadness, anxiety, anger, and fear.

4.5.6 Results

Data analyses were performed through the statistical software IBM SPSS 23.0 and R programming language (version 4.2.3) with the ggplot2 package implemented for data visualization.

4.5.6.1 Preliminary Check

An inspection of Kurtosis and Skewness was conducted to determine if variables were normally distributed. All variables emerged as normally distributed. As a preliminary check, a series of one-way analysis of variance (ANOVAs) were conducted to check for possible participants' differences at baseline in the PANAS and in the previous experience with VR measures between conditions. These analyses revealed no significant differences across conditions in terms of these pre-exposure variables.

4.5.6.2 Self-Report Measures Analyses

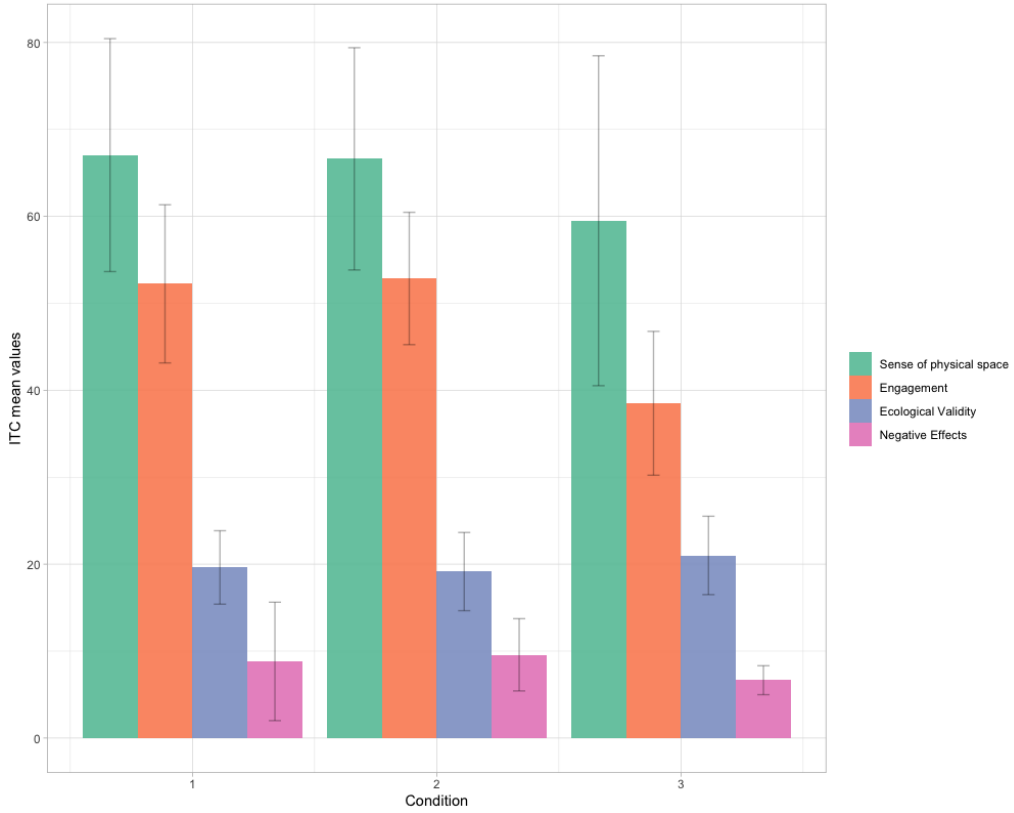
One-way ANOVAs were conducted to compare results in the ITC-SOPI and PANAS in the three different conditions (Table 4):

Table 4: Results of One-Way ANOVAs for the ITC - SOPI and PANAS Measures.

	Condition	Mean	SD	One-way ANOVA (Equal variances assumed)		
				F (df=2)	P-value	Eta squared ($\eta 2$)
Sense of Physical Space	CSum	67.05	13.39	1.57	.216	.051
	CSans	66.62	12.78			
	CPhys	59.50	18.97			
Engagement	CSum	52.24	9.09	19.20	.001	.394
	CSans	52.86	7.61			

	CPhys	38.50	8.27			
Ecological Validity	CSum	19.62	4.22	.974	.383	.032
	CSans	19.14	4.49			
	CPhys	21.00	4.50			
Negative Effects	CSum	8.81	6.80	2.08	.134	.066
	CSans	9.57	4.15			
	CPhys	6.65	1.66			
Positive Affect	CSum	38.10	8.40	5.16	.009	.149
	CSans	39.81	5.76			
	CPhys	32.95	6.83			
Negative Affect	CSum	13.67	11.32	.852	.432	.028
	CSans	11.00	1.76			
	CPhys	11.65	3.83			

The results showed significant differences in the *Engagement* subscale scores, measured through ITC -SOPI ($F = 19.203$, $p = .000$, $\eta 2 = .394$). Subsequent post-hoc pairwise comparisons, corrected with *Bonferroni* test, specifically showed that both CSum and CSans significantly differ in terms of *Engagement* with respect to CPhys ($p = .00$; $p = .00$). No significant differences were observed between CSum and CSans ($p = .969$). Specifically, CSum ($M = 52.24$, $SD = 9.09$) and CSans ($M = 52.86$, $SD = 7.61$) obtained significantly higher scores than CPhys ($M = 38.50$, $SD = 8.27$) (Table 4; Graph 1).

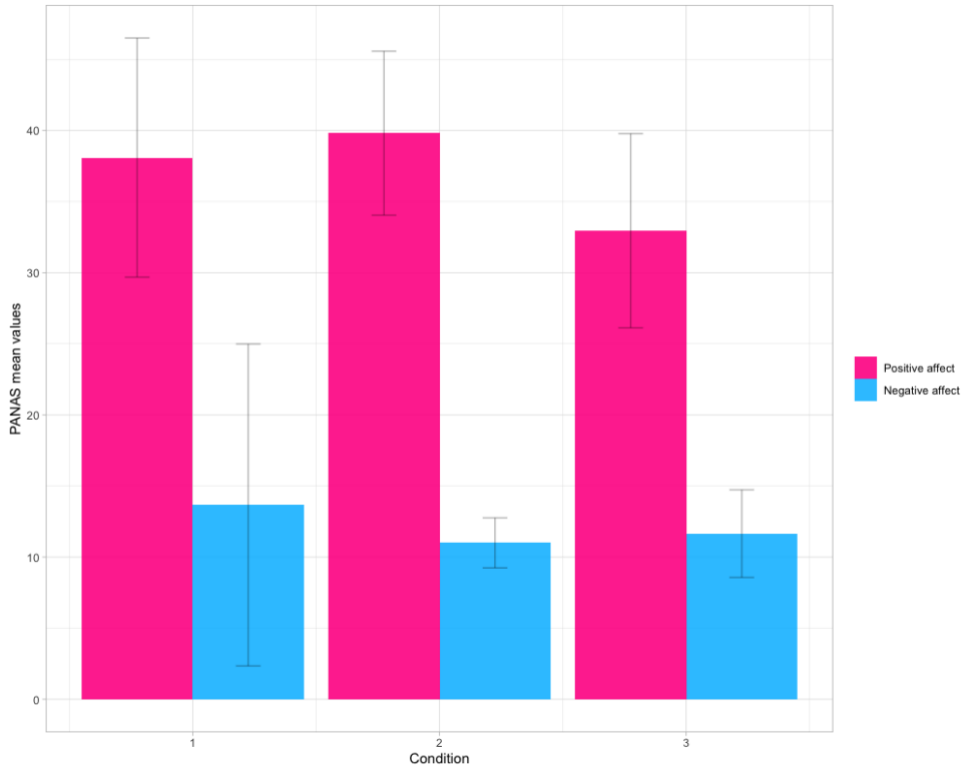


Graph 1: Bar Plot Depicting Mean Values for the ITC-SOPI Measure for CSum, CSans and CPhys.

The results showed significant differences also in the *PA* subscale scores, measured through the PANAS ($F = 5.162$, $p = .009$, $\eta 2 = .149$).

Subsequent post-hoc pairwise comparisons, corrected with *Bonferroni* test, specifically showed that CSans showed a significant difference in *PA* subscale compared to CPhys ($p = .008$). No significant differences were observed between CSum and CPhys ($p = .060$) and between CSans and CSum ($p = .715$).

Specifically, CSans obtained a significantly higher score ($M = 39.81$, $SD = 5.76$) than CPhys ($M = 32.95$, $SD = 6.83$) (Table 5; Graph 2).



Graph 2: Bar Plot Depicting Mean Values for the PANAS Measure for CSum, CSans and CPhys.

Independent samples t-tests were conducted to compare results in the OPQ between the two virtual conditions (i.e., CSum and CSans).

The results showed a significant difference in the *Realism* subscale scores (t = -.127, p = .027, df = 40). Specifically, CSum (M = 40.95, SD = 4.97) obtained significantly lower scores than CSans (M = 41.19; SD = 6.99) (Table 5).

Table 5: Results of Independent Sample t-tests for the OPQ Measure.

	Condition	**Mean**	**SD**	**Independent samples t-tests**	
				t (df=40)	P-value
Quality of Interface	CSum	8.71	4.45	.365	.974
	CSans	8.24	3.99		
Realism	CSum	40.95	4.97	-.127	.027
	CSans	41.19	6.99		
Involvement	CSum	17.71	3.22	.252	.901

	CSans	17.48	2.89		

Furthermore, we separately calculated correlations among *PA* and *NA* measures and the ITC-SOPI, for each experimental condition, in order to assess potential relationships between affective states and participants' degree of immersion/ presence and engagement within the environment (Table 6).

Regarding CSum, PA positively correlated with the ITC SOPI subscales *Sense of Physical Space* (r = .812, p = < .001), *Engagement* (r = .810, p = < .001) and *Ecological Validity* (r = .606, p = < .001). Moreover, for CSum PA also negatively correlated with the ITC SOPI subscale *Negative Effects* (r = -.585, p = .005). For CSum, NA negatively correlated with the ITC SOPI subscales *Sense of Physical Space* (r = -.689, p = < .001), *Engagement* (r = -.731, p = < .001) and *Ecological Validity* (r = -.569, p = .007), and positively correlated with *Negative Effects* (r = .972, p = < .001).

Regarding CSans, PA positively correlated with the ITC SOPI subscales *Sense of Physical Space* (r = .490, p = .024) *and Engagement* (r = .598, p = .004). For CSum, NA positively correlated with *Negative Effects* (r = .506, p = .506).

Regarding CPhys, PA positively correlated with the ITC SOPI subscales *Sense of Physical Space* (r = .447, p = .048) *and Engagement* (r = .726, p = < .001).

Table 6: Pearson Correlations Computed Between ITC-SOPI and PANAS Dimensions (NA and PA) among CSum, CSans and CPhys.

Pearson Correlations					
	Condition	***Positive Affect (PA)***	**P-value**	***Negative Affect (NA)***	**P-value**
Sense of Physical Space	CSum	.812**	< .001	-.689**	< .001
	CSans	.490*	.024	-.238	.299
	CPhys	.447*	.048	.374	.104
Engagement	CSum	.810**	< .001	-.731**	< .001
	CSans	.598**	.004	.011	.962
	CPhys	.726**	< .001	.265	.259
Ecological Validity	CSum	.606**	.004	-.569**	.007
	CSans	.232	.311	-.170	.460

	CPhys	.080	.736	.148	.534
Negative Effects	CSum	-.585**	.005	.972**	< .001
	CSans	-.097	.674	.506*	.019
	CPhys	.383	.096	.273	.245

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.5.7 Discussion

Previous research has highlighted a significant gap in our understanding of the perceptual, cognitive and affective aspects of experiencing a product in a virtual context compared to its physical counterpart.

The primary goal of this study was to address this gap by comparing the experience of a design product, the *Graziella* bicycle, in virtual *vs* real environments. Specifically, this study aimed at assessing the Sense of Presence, Immersion, Emotional Engagement and the Perceived Quality of the Product within these settings. Concerning the virtual environments, the study compared the characteristics of two virtual platforms - *Sumerian and Sansar* for assessing potential differences among different types of platforms.

4.5.7.1 Virtual vs. physical experience of the product

The results of our study showed differences in two dimensions between the virtual (CSum, CSans) and the physical experience of the product (CPhys); *Engagement* and *Positive Affect*.

Participants belonging to the virtual conditions reported greater levels of *Engagement* with respect to participants belonging to the physical one. We know that the novelty factor of VR typically contributes to increased engagement. Participants are likely to find virtual experiences intriguing and exciting [48,49], as VR technologies still represent a relatively novel and cutting-edge phenomenon. However, given that our inclusion criteria included having some prior experience with VR technology, we could presumably exclude that this finding is solely related to the so-called "wow effect", linked to the intrinsic capacity of immersive technologies (e.g., Virtual Reality, Augmented Reality, and online videos) to generate awe experiences. [50]

Also, if we look at earlier conceptualizations of *Engagement,* within the framework of information-system development, predominantly considered it as a process[51], namely, as a task-oriented aspect. In this perspective, engagement is seen as a step-by-step sequence or set of activities within the broader development process. It emphasizes the actions and tasks undertaken during the creation or implementation of an information system, often focusing on the efficiency and effectiveness of these processes.

Contrarily to this, conceptualizing *Engagement* as a quality of the user experience places emphasis on the subjective and experiential aspects of users' interactions with technology. In this view, engagement is not solely a procedural outcome but rather a nuanced and intrinsic attribute of how users perceive and interact with the technology. [52] It encompasses emotional, cognitive, and sensory dimensions, reflecting the depth and richness

of the user experience with VR technology. In light of these considerations, we could hypothesize that the heightened engagement observed within the VR conditions may have introduced a positive bias in the overall evaluation of the experience. This potential bias necessitates a cautious interpretation of the higher engagement levels in VR compared to the real world. It is possible that the immersive and novel aspects of VR technology may amplify users' perceived engagement, overshadowing certain limitations or less engaging aspects of the VR experience that might become more apparent with repeated or prolonged exposure. Therefore, while the initial enhanced engagement in VR is an important finding, its long-term sustainability and impact on user experience require further investigation to fully understand the dynamics of user engagement in VR settings.

It is possible that our findings related to greater *Positive Affect* found in participants belonging to the virtual conditions might as well be related to this. Enhanced positive emotions during VR experiences compared to real ones has been found in other domains, such as education[53], architecture[38] and exposure to virtual *vs* real nature. [54]

For what concerns the physical condition, the significant positive correlation between *Engagement* and positive emotions suggests that, even in the absence of VR technology, user engagement relates to emotional experiences.

This aligns with research emphasizing the role of physical product engagement in influencing users' emotional responses. [55]

In conclusion, the results highlighted crucial factors inherent in VR during a virtual prototyping process, emphasizing the potential feasibility of integrating VR into UX testing.

The findings emphasize how this technology can make a virtual product experience credible, authentic, and, in some cases, psychologically more impactful than encountering the same product in a physical environment. This phenomenon leads users to perceive events within the virtual context as genuine occurrences, like reality. [56,57]

4.5.7.2 Comparison between the virtual product experiences: Sumerian vs. Sansar

Notably, our results revealed no significant differences in ITC-SOPI dimensions between the two VR platforms, suggesting that they might elicit similar levels of sensor fidelity, perception of physical space, psychological involvement, and adverse reactions. However, a significant difference emerged in the OPQ subscale related to *Realism*, wherein Sansar obtained higher scores.

This difference in realism ratings can be attributed to Sansar's advanced graphical capabilities, creating a more visually sophisticated virtual environment compared to Sumerian. The heightened realism in Sansar could have influenced participants to perceive the virtual environment as more authentic, thus resulting in elevated realism ratings compared to the Sumerian platform. This observation underscores the impact of graphical fidelity on users' perception of realism in virtual experiences.

Furthermore, our study showed significant correlations between various dimensions of the ITC-SOPI and participants' emotional states within both virtual environments. In the CSum condition, the Sense of Physical Space, Engagement, and Ecological Validity subscales exhibited positive correlations with Positive Affect and

negative correlations with Negative Affect. In Sansar, these correlations were evident specifically for the Sense of Physical Space and Engagement, and only positive correlations were observed.

Thus, participants who reported heightened engagement and positive spatial perceptions in the virtual environments also reported experiencing more positive emotions. Conversely, those reporting negative effects in these virtual environments tended to experience higher levels of negative emotions. These findings align with existing literature on the relationship between presence (including dimensions like spatial presence, engagement, and ecological validity) and emotional engagement within virtual environments. [58,36,51] The positive correlations observed for virtual experiences are in line with studies suggesting that a heightened sense of presence and engagement in virtual environments can enhance emotional responses. [22,58] This can be partially attributed to the immersive nature of well-designed VR, where users often suspend their disbelief and become emotionally involved in the virtual experience. [17]

If, on one hand Suspension of Disbelief is not a necessary, credible, or explanatorily powerful component of presence experiences in VR,[59] on the other hand, it is optimized by the physical, functional, and psychological fidelity of the simulation.[60] Especially in design-related contexts, a more realistic environment, able to achieve a higher fidelity with the actual environment which the VR is emulating, elicits a better experience from the users.[61]The positive association between engagement and positive emotions, as well as the link between negative effects and negative emotions, underscores the importance of designing VR experiences and using VR tools that promote user engagement while minimizing potential discomfort or negative side effects. [27,30] Such considerations are critical when aiming to create emotionally compelling virtual experiences. Conversely, differences in the evaluations of the two platforms can be attributed to the unique characteristics inherent to each platform. As observed, Sansar's enhanced graphics and dynamic lighting effects played a pivotal role in creating a highly immersive experience, in contrast to the relatively simpler visual aesthetics of the Sumerian platform. This discrepancy in visual fidelity and aesthetics likely contributed to variations in participant evaluations of the two platforms.

4.5.8 Conclusions

The results of our investigation have unveiled minimal differences between the virtual and real evaluation conditions, particularly concerning perception of realism and sense of presence. This finding underscores the feasibility and reliability of utilizing VR for UX research, in line with prior research, [37,38] which suggests a lack of substantial disparities in terms of object realism and environment presence between the two settings, affirming the promising utility of VR.

Nevertheless, our exploration extended beyond technical considerations into the realm of emotional engagement. Notably, our study revealed that participants reported heightened levels of engagement and positive affect in the VR conditions with respect to the physical one. Among the virtual platforms used, Sansar received higher evaluations across various product aspects considered in this study. These findings suggest that

VR not only demonstrates technical feasibility but also holds psychological significance, offering motivation and positive emotional experiences to users.

However, it is crucial to acknowledge several potential caveats. Firstly, the imbalance in participant groups, with respect to gender. While our current analyses did not specifically examine differences between males and females in their virtual versus real experiences with the same product, it is imperative for future research in VR user experience to prioritize a more equitable distribution across gender groups. This approach will undoubtedly enhance the comprehensiveness of our insights, contributing to a richer understanding of the technology's impact across different demographic groups.

Secondly, the volume of questions participants was required to answer may have imposed a cognitive burden on participants, potentially influencing their level of interest and engagement, particularly at the end of the questionnaire. Future studies have to consider reducing the length of the questionnaire, selecting the most relevant items.

Thirdly, as already highlighted in the Discussion, the heightened engagement observed within the VR conditions may have introduced a positive bias in the overall evaluation of the experience. While participants reported more positive emotions in the virtual environment, this emotional uplift should be approached cautiously when interpreting the overall product assessment. Although our study represents an exploratory effort, it underscores the strategic and innovative potential of VR for evaluating UX concerning physical products. To further enhance the realism and effectiveness of virtual product UX, conducting a comprehensive evaluation replicating tactile experiences of materials and textures from the virtual product would be beneficial. Such an approach could not only improve visual impressions but also enhance the perception of essential product attributes. Future research trajectories might consider intensifying interaction with virtual products, engaging vital sensory channels like sight, hearing, and touch. [62,63,64] Additionally, incorporating other types of measures (i.e., physiological)[65] and examining the potential to gauge purchase intent, a fundamental aspect in UX research and design, could further enhance our understanding of user experiences with these virtual environments. [66]

Furthermore, considering the evolving landscape of social virtual environments, notably the Metaverse, there exists the opportunity to enhance the evaluation of product UX in virtual settings. Simulating social contexts within these environments could provide a more ecologically valid representation of real-world product usage, offering a comprehensive and realistic backdrop for UX assessments.

4.6 Augmenting Aesthetic Experience through VR

4.7 Study 3: “Being Immersed in Aesthetic Emotions: Comparing Immersive Vs. Non- Immersive VR in Aesthetic Emotions Elicitation”

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* All references for this study have been compiled and are available in Appendix 2.

4.7.1 Abstract

Virtual Reality (VR) changed the ways through which art is produced and also experienced by the audience.

VR can convey effective emotional and aesthetic experiences thanks to the sense of presence.

So far, previous studies have mostly focused on the cognitive implications of using virtual environments in aesthetic contexts. However, empirical studies testing whether and how immersion, sense of presence and engagement are able to emphasize emotional responses to artworks, compared to their simple 2D reproductions, are still scarce.

In this study, we tested a new immersive aesthetic format of conventional 2D paintings consisting in a 360° spherical representation of the same paintings, enriched with narratives and music.

This preliminary study aims at testing the role of immersion and sense of presence in promoting aesthetic emotions, in terms of aesthetic appreciation and emotional responses.

To test this objective, in a within subject-design, each participant is exposed in a counterbalanced order to the new aesthetic format consisting of a set of virtual highly immersive paintings presented in a 360° environment (immersive condition) and to the same set of virtual paintings presented on a simple 2D virtual screen (non-immersive condition). Aesthetic emotions were measured through the AESTHEMOS scale containing 21 subscales covering prototypical aesthetic emotions, epistemic emotions and emotions indicative of amusement. Also, measures related to immersion, sense of presence, engagement and perceived novelty of the stimuli were assessed. Finally, self-report questionnaires measuring people’s broader engagement with the arts and humanities, disposition to experience positive emotions and general aesthetic interest were administered to participants.

For this preliminary study, we expected artworks to be judged more aesthetically pleasant and emotionally engaging compared to the same set of non-immersive stimuli, presented on a 2D screen. Moreover, we hypothesize immersion, sense of presence and engagement to positively correlate with higher aesthetic appreciation of those stimuli.

4.7.2 Introduction

The emergence of new digital media has had a significant impact on both the creation and perception of art. With the advancement of technology, artists have been able to create new forms of art that were previously impossible or difficult to achieve through traditional methods [1,2]. Digital media have also changed the way we perceive and experience art, since they have enabled new forms of audience engagement, such as participatory installations and interactive exhibitions, which allow viewers to become active participants in the creation and interpretation of art [3, 4].

Virtual Reality (VR) has become an increasingly popular tool for artists to create immersive and interactive art experiences since it allows creating virtual worlds and spaces that viewers can explore and interact with, providing a new level of engagement and interactivity with the artwork [5]. According to Kim and Lee, in a virtual environment, the observer becomes an active participant in the creation of the aesthetic experience, rather than a passive viewer [6].

VR is a powerful *affective* medium that is able to generate strong emotional responses, thanks to the experience of presence and immersion. This is achieved through a combination of sensory stimuli, including visual, auditory, and haptic feedback, as well as the ability to interact with and navigate within the virtual environment [7,8,9].

4.7.2.1 Presence and aesthetic emotions

Presence is usually defined as the feeling of "being and acting there" [10,11,12]. Presence can be enhanced by realistic graphics and sounds, as well as by the ability to interact with objects and characters in the environment. Narrative content is also a chief actor in increasing the sense of presence [13,14,15,16].

Aesthetic emotions have been recently introduced and analyzed in the psychological literature [17]. These emotions arise from our engagement with art, music, literature, and other forms of creative expression. They can be differentiated from other types of emotions, such as basic emotions like anger or sadness, in that they are more complex and often have a longer duration. Aesthetic emotions can be both positive and negative [18]. Positive-valenced aesthetic emotions include emotions such as awe, wonder, and joy. These emotions are often associated with feelings of transcendence or a sense of being connected with something that is perceived as greater than ourselves [19]. Another important feature of aesthetic emotions is that they are highly subjective. Different people may have different emotional responses to the same piece of art, music, or literature, and these responses may change over time and with repeated exposure [20].

To sum up, immersion and sense of presence are crucial aspects of the VR experience, as they allow users to feel emotionally involved and fully engaged within the simulated environment. Lots of studies have been conducted to test the impact of immersion and sense of presence on emotional responses of participants induced by emotionally charged stimuli compared to neutral ones [21,22,23]. However, few studies have investigated the link between immersion, sense of presence and aesthetic emotions induced by artworks [24,25]. In this

study, we tested a new immersive aesthetic format of conventional 2D paintings consisting of a 360° spherical representation of the same paintings, enriched with narratives and music.

Specifically, the main hypotheses are that i) *immersive paintings elicit more intense emotional responses than non-immersive ones in terms of aesthetic emotions*; ii) *aesthetic emotions are related to the levels of immersion, sense of presence, and engagement felt by participants*. By examining the interplay between immersion, sense of presence, engagement, and aesthetic emotions, the study seeks to contribute to the field of aesthetics and deepen our comprehension of how individuals interact with artistic stimuli.

4.7.3 Methods

4.7.3.1 Sample

The study involves twenty participants aged between 18 and 60 (mean age = 35.88 years; S.D = ± 11.01). Participants were volunteers and did not receive any payment or credit for their collaboration.

4.7.3.2 Stimuli

To verify the above hypotheses, stimuli for the immersive condition were chosen from an app, available on Meta Quest store, *Art Plunge*, which is a virtual gallery where the observer can get the feeling of being inside famous paintings. The gallery features 5 VR interpretations of the following artworks: *Mona Lisa* by Leonardo da Vinci (1503), *Starry Night* by Vincent Van Gogh (1889), *The Birth of Venus by* Sandro Botticelli (1863), *The Creation of Adam* by Michelangelo (1512), and *Girl Reading a Letter at an Open Window* by Johannes Vermeer (1659). These artworks have been designed to fully engage the viewer's senses and create a multi-sensory experience by incorporating sound, movement, and other sensory elements. Stimuli for the non-immersive condition include the five paintings (*Mona Lisa, Starry Night, The Birth of Venus, The Creation of Adam* and *Girl Reading a Letter at an Open Window)* in their 2D format, displayed on a virtual screen.

4.7.3.4 Experimental design and materials

The experiment involved a *within-subjects* design. Each subject experienced both the immersive condition consisting in the five virtual paintings from *Art Plunge* app and non-immersive condition, consisting of the five paintings displayed in their 2D format. The 10 virtual stimuli - immersive and non-immersive paintings - were run on a standalone Head Mounted Display (HDM) (MetaQuest 2) and their order of presentation was randomized. Navigation and movement within the environment were possible through the use of a wireless joystick. Narratives and music during the exploration were played by headphones incorporated into the HMD.

4.7.4 Measures and Instruments

Aesthetic disposition

Participants' disposition to live positive emotions (Disposition Positive Emotions Scale)– DPES [26]– and their general aesthetic interest for literature, art, cinema, design, food and nature (Desire for Aesthetics Scale-DFAS) [27] was assessed before the experimental session.

Aesthetic emotions

After each experimental condition aesthetic emotions were assessed through AESTHEMOS scale [28]. The scale contains 21 subscales with two items each, that are designed to assess the emotional signature of responses to stimuli's perceived aesthetic appeal in a highly differentiated manner. Also, before the experimental session and after each experimental condition, the Italian PANAS [29] version was used to capture the two main clusters of the affective experience.

Perceived connectedness with the artist

After each experimental condition, participants rated how much they felt connected to the artist through the Inclusion of Other in the Self Scale [30]. Respondents see seven pairs of circles that range from just touching to almost completely overlapping. One circle in each pair is labeled "self," and the second circle is labeled "other," that is, the artist. Respondents choose one of the seven pairs to answer the question, "Which picture best describes your relationship with the artist?".

Immersion, sense of presence, engagement and familiarity

After viewing each painting, participants are asked by the experimenter to rate their perception of the painting using four rating scales, ranging from 0 to 100, that included items measuring immersion, sense of presence, engagement and perceived novelty of the stimulus ("Quanto ti sei sentito presente all'interno dello scenario che hai appena osservato?", *"How present did you feel within the scenario you just observed?"*; "Quanto ti sei sentito immerso all'interno dello scenario che hai appena osservato?", *"How immersed did you feel within the scenario you just observed?"*; "Quanto lo stimolo ti ha coinvolto?", *"How involved did the stimulus make you feel?"* ; "Quanto avevi familiarità con lo stimolo appena visto?", *"How familiar were you with the stimulus you just saw?"*).

4.7.5 Procedure

The day of the experiment, participants were welcomed and instructed to sit comfortably in a quiet room and completed the online questionnaires before the experimental session took place. They were then instructed on how to wear the virtual reality headset and manipulate the two controllers. Participants were exposed both to the virtual gallery from *Art Plunge* app, containing the highly immersive virtual paintings and to the same set of virtual 2D paintings, in a counterbalanced, with a break in between. After viewing each painting, participants rated their perception of the painting using four rating scales, ranging from 0 to 100, that included items measuring immersion, sense of presence, engagement and perceived novelty of the stimulus. After each set of paintings, participants were required to complete post-questionnaires, aimed at measuring the overall experience. Participants were also given the opportunity to provide open-ended feedback at the end of their experience.

4.7.6 Results

Aesthetic disposition

We computed total scores related to each dimension of DPES scale (Joy, Compassion, Amusement, Love, Pride, Awe) and overall score of DFAS scale obtained by participants (Table 7). DPES is structured by seven different scales, each representing a specific positive emotion: Joy (6 items), Contentment (5 items), Pride (5 items), Love (6 items), Compassion (5 items), Amusement (5 items), and Awe (6 items). The 38 items are presented to responders in a seven-step Likert scale ranging from Strongly Disagree (1) to Strongly Agree (7). For all subscales of the Disposition for Positive Emotion scale, the minimum possible score is 0. The maximum possible score for the Joy, Love, and Awe subscales is 42, while for all other subscales it is 36.

Regarding DFAS, the minimum possible score on this initial 36-item DFAS is 0, and the maximum possible score is 240. A completely neutral score would be 120, and higher scores indicate a greater desire for aesthetics in daily life.

Table 7: Descriptive statistics related to each dimension of DPES scale and DFAS scale.

	Mean	**Std. Deviation**
DFAS	134.11	15.52
Joy	4.33	.47
Compassion	5.40	.55
Amusement	4.80	.93
Love	4.28	1.12
Pride	4.80	.55
Awe	5.11	.59

N=20

4.7.6.1 Aesthetic emotions in Virtual Reality

Paired-samples t-tests were conducted on each separate subscale of AESTHEMOS scale. Results showed a significant difference for all the subscales apart from Humor, Relaxation, Feeling of Ugliness, Anger, Uneasiness and Sadness (see Table 8 for all results).

Table 8: Descriptive statistics of each dimension of AESTHEMOS scale for both immersive and non-immersive condition.

	Mean		Std. Deviation		Paired t-test (Equal Variances assumed)		
	Immersive	Non-immersive	Immersive	Non-immersive	T (df =19)	p	D(Cohen)
Beauty	6.50	5.27	.79	1.06	5.93	**.00**	.61
Fascination	6.33	3.72	.66	1.58	5.55	**.01**	1.40
Being Moved	5.38	3.33	1.86	1.45	3.92	**.04**	1.57
Awe	5.66	3.50	1.00	1.00	6.50	**.00**	1.00
Enchantment	6.27	3.83	1.50	1.39	6.05	**.00**	1.21
Nostalgia	4.33	3.11	1.62	1.57	2.76	**.024**	1.32
Joy	5.83	4.87	1.11	1.40	3.74	**.01**	.75
Humor	4.88	4.16	1.45	1.22	1.88	.09	1.14
Vitality	5.72	3.61	1.32	1.24	4.99	**01**	1.26
Energy	5.05	3.50	1.68	1.25	4.60	**.00**	1.01
Relaxation	5.16	4.38	1.34	.89	1.86	.10	1.25
Surprise	4.27	2.66	1.27	1.08	3.96	**.00**	1.21
Interest	6.27	5.05	1.00	1.18	3.27	**.01**	1.12
Intellectual Change	5.72	4.55	.93	1.15	6.26	**.00**	.55
Insight	5.05	3.33	1.37	1.29	3.53	**.00**	1.46

Feeling of ugliness	1.55	1.50	.16	.00	1.00	.34	.16
Boredom	1.88	2.44	.76	.41	2.85	**.02**	.58
Confusion	2.11	1.77	.68	.50	2.82	**.02**	.70
Anger	1.61	1.61	.33	.33	.00	1.00	.50
Uneasiness	2.00	1.50	.90	.00	1.66	.13	.90
Sadness	2.44	2.22	1.28	.56	.59	.56	1.12

A Wilcoxon Signed-Ranks Test indicated that the perception of connectedness to the artist rated by participants in the immersive condition was significantly higher than the perception of connectedness to the artist rated by participants in the non-immersive condition (Z = -2.56, p = .010).

4.7.6.2 The link between immersion, sense of presence, engagement and aesthetic emotions

A paired-samples t-test was conducted on total scores related to immersion, presence, engagement and familiarity computed on the mean ratings participants gave for each painting from the immersive and non-immersive condition. A first analysis showed a significant difference between the two conditions for all dimensions but familiarity [t(immersion) = 10.65, p <.001, d= 10.90; t(presence) =6.34, p <.001, d= 16.36; t(engagement) =5.66, p <.001, d= 15.04]. Specifically, participants gave higher rates related to immersion, presence and engagement after viewing immersive paintings compared to non-immersive paintings (see Table 9 for all results).

Table 9: Descriptive statistics of ad-hoc items related to immersion, presence, engagement, familiarity for both immersive and non-immersive conditions.

	Mean		**Std. Deviation**	
	Immersive	**Non-immersive**	**Immersive**	**Non-immersive**
Immersion	94.80	56.06	5.34	13.58
Presence	93.06	58.44	4.37	17.13
Engagement	93.82	65.40	5.10	15.62
Familiarity	93.42	89.62	6.70	5.97

N= 20

To better explore the possible link between emotion and presence, we analyzed in both conditions the correlations between the level of immersion, presence, engagement and the emotional level experienced after each experience.

In the immersive condition, a positive correlation emerged between presence and insight dimension of AESTHEMOS scale [r(19)= .782, p= .05] and between immersion and both fascination and beauty dimensions of AESTHEMOS scale [r(19)= .688, p= .05; r(19)= .784, p= .05] while in the non-immersive condition, negative correlations emerged between sense of presence and humor and relaxation dimension of AESTHEMOS scale [r(19)= -.744, p= .05, r(19)= -.836, p= .01].

4.7.7 Discussion and conclusions

In this study we compare the aesthetic emotions felt by observers in response to immersive and non-immersive paintings. The study used a quantitative approach to gather data from participants who were shown both types of paintings and asked to report their emotional responses.

The results of the study showed that participants reported a higher level of aesthetic emotions when viewing immersive paintings compared to non-immersive paintings. Immersive paintings were found to elicit stronger feelings of awe, fascination, inspiration, enchantment, joy, surprise and relaxation and were found to be more intellectually challenging. On the other hand, non-immersive paintings were associated with boredom. Moreover, results from the IOSS scale showed that participants felt a deeper connection with the artist in the immersive condition compared to the non-immersive one. Also, correlations between immersion and sense of presence scores and AESTHEMOS dimensions showed that immersive paintings engage the viewer's attention more fully and create a greater sense of presence and involvement, leading to stronger aesthetic emotional responses. Our findings suggest the importance of immersion and the sense of presence as mediating variables between the media experience and the aesthetic emotions induced by it.

Overall, the study provides insight into the potential of immersive art to elicit strong emotional responses from viewers. It highlights the importance of considering the immersive qualities of artworks in the evaluation of their aesthetic impact. These results, even if preliminary, could have interesting implications for artists, curators, and art enthusiasts, as well as for the development of immersive technologies in the art world. Immersive technologies offer the potential to create highly immersive and interactive art experiences that can evoke strong emotional responses in viewers, and potentially transform their aesthetic perceptions and experiences.

This study has some caveats. First, as a pilot study, the size of the experimental sample was limited. So, for some analyses the statistical power was low. Second, we measured emotional states using self-report questionnaires only. Even if the assessment tools used were validated and effectively tested in different contexts, the use of physiological indexes may help in obtaining a more complete picture of the emotional response of the user.

Further research is needed to explore the mechanisms underlying the emotional impact of immersive art and to investigate the role of individual differences in the perception of immersive and non-immersive paintings.

4.8 Key points of the chapter and conclusions

In conclusion, this chapter has explored the key aspects and potential applications of immersive technologies, particularly focusing on Virtual Reality (VR). By tracing its historical development from early conceptualizations to the sophisticated systems of today, I have highlighted VR's evolution into a highly immersive medium capable of transforming user experiences.

The chapter also presented two empirical studies that demonstrated VR's capacity to simulate real-world environments and evoke meaningful psychological responses. The first study, which compared virtual and real product experiences, highlighted how VR can provide levels of engagement and emotional impact that can rival or even surpass those of physical interactions. This underscores the applicability of VR in design and UX research, offering an innovative approach to product testing in controlled, immersive settings. The second study, focusing on aesthetic emotions, showed how VR enhances emotional responses to art through immersion and presence, suggesting its powerful potential in the cultural and artistic domains.

These studies illustrate the breadth of VR's applications, from enhancing UX research to transforming artistic experiences, making it a versatile tool across multiple fields. Although some limitations, such as technological constraints and the need for further refinement, remain, VR continues to offer significant advantages over traditional methods. As it becomes increasingly integrated into diverse sectors—including education, healthcare, entertainment, and cultural heritage—VR's potential to deepen our understanding of human perception and emotional responses will further cement its role as a key technology for both scientific inquiry and practical innovation.

5. Integrating Aesthetics, Emotions and Technology in UX: a focus on the Environment

In the discipline of UX, the significance of space and context cannot be overstated when evaluating an artifact. Space, in this sense, extends beyond its conventional “architectural” definition to encompass both the physical features of the environment in which an artifact is placed and its experiential dimensions when interacted with. This dual perspective on space integrates it not only as a backdrop for human activities but as an essential component of the experience itself. Reflecting on historical and contemporary design practices, it becomes apparent that both the presentation context of the artifact (or the experience of space as an artifact in its own right) fundamentally influence the UX.

This final chapter aims at addressing this issue, by integrating aesthetics, emotions and technology.

Thus, this chapter is structured to provide an introduction on the importance of space relying on the first piece of evidence from philosophy and social psychology and extending to insights from environmental psychology. Finally, drawing upon some influential theoretical paradigms, the role of space in the UX realm, with a proposal on the dimensions to be explored, will be presented.

5.1 Differentiating between *Space*, *Place* and *Environment*

In human experience and life in general, existence is closely related to occupying space and moving within it; thus, space is not merely the context of human actions but an integral part of them (Bettanini, 1976; Evans, 2003). To comprehensively understand the influence of spatial contexts on human experience, it is essential to differentiate between the concepts of "space," "place," and "environment." In UX design, these distinctions are crucial for creating environments that not only function effectively but also resonate emotionally and culturally with users. This approach is reflected in the evolution of architectural and urban design, where the integration of subjective, creative, and aesthetic considerations has become increasingly important (Ricci, 2021).

Space refers to the physical dimension within which human activities occur. It is typically understood in an abstract, objective sense, characterized by measurable properties such as distance, area, and volume (Tuan, 1977; Lefebvre, 1991). In the realm of architecture and design, space is viewed as the geometric framework where movements and interactions take place. It is often devoid of personal significance but plays a crucial role in shaping behavior through its physical characteristics (Harvey, 2006). Actually, historically and perhaps, more intuitively than through a rigorous and systematic approach, planners, architects, and designers have dedicated themselves to creating spaces that meet the needs and promote the well-being of individuals (Salam, 2020). This commitment is evident both in the embellishment of public spaces and in the optimization of the functionality and comfort of domestic ones.

Let’s consider some examples. As for domestic spaces, home, as the primary refuge of the individual, has always required special attention in designing spaces that guarantee privacy, intimacy, and security. Living space plays a central role in daily life, profoundly influencing the formation of individual identity and contributing to the creation of significant relationships. From birth, this space is shared with loved ones, and throughout life, it contains memories that evoke feelings of comfort and protection (Chow & Healey, 2008). Housing represents a crucial factor in meeting the primary needs of individuals, contributing to the creation of a basic sense of belonging, which is fundamental for becoming active citizens (Maksimovic, 1969).

However, individuals also spend a significant amount of their time outside the home, attending public spaces that facilitate socialization and the building of social bonds (Bell et al., 2018). These social spaces, such as squares, cafes, and schools, play a crucial role in social development and community cohesion (Hetherington, 1997; Warner, Talbot & Bennison, 2012). Unlike domestic ones, public spaces form the intersection between the public and private spheres (Shapira & Navon, 1991), offering continuous experiential stimuli (Dovey, 2016). Furthermore, public spaces should promote social cohesion within neighborhoods (Kazmierczak, 2013; Villanueva et al., 2015). Therefore, the design of public spaces must consider not only accessibility and functionality but also aesthetic and environmental aspects to meet cultural, social, and recreational needs (Mitkovic & Bodganovic, 2004).

During adulthood, workspaces become particularly significant, being designed and organized specifically to foster a productive environment for organizational goals (Alexander et al., 2004; Riratanaphong, 2009). The design of such spaces must respect employees' needs while simultaneously addressing organizational requirements, aiming to stimulate performance through innovative design (Riratanaphong, 2009).

It is worth noting that all the disciplines related to the design of both private and public spaces, including (but not limited to) architecture, design and urban planning, with the primary aim to organize the human-inhabited space and/or environment where people live and originally created as a means to provide protection or shelter from the surrounding environment (in the case of domestic spaces) and to attend and share their lives with other people (in the case of public ones), has gradually evolved into art forms, incorporating subjectivity, creativity, and beauty as gold standards to reach the previous goals (Ricci, 2021). This underscores the importance of considering not only functional aspects but also psychological needs, in terms of perceptual/aesthetic, affective and cognitive ones, of the occupants.

Therefore, over time, over time, as in the UX domain, there has been an increasing recognition of the psychological dimensions in the design of spaces. However, disentangling the perceptual, cognitive, and affective processes involved in human interaction with space is a significant challenge. This complexity arises because such interaction frequently entails dynamic movement within the space rather than mere contemplation of a static stimulus, such as artwork. Various disciplines contribute to our understanding of these dimensions: neuroscience provides insights into spatial perception, while philosophy, sociology, and social psychology explore cognitive processes and their impacts on behavior. It is important to note that this complexity has also led to a certain enrichment of terminology. For instance, the concept of "place" emerged as a result.

Place is space imbued with meaning through human experience, interaction, and memory. It becomes significant as individuals or communities assign emotional and symbolic value to it, often through social, cultural, or historical contexts (Tuan, 1977; Cresswell, 2004). In sociology and anthropology, the concept of place is central to understanding how people establish identity and a sense of belonging. Relph (1976) describes place as a "profound center of human existence," where personal and collective experiences converge. The transition from space to place occurs as people engage with their environment, transforming abstract spaces into meaningful locations. This is evident in the way social spaces like squares, cafes, and schools serve as venues for social development and community bonding (Warner, Talbot & Bennison, 2012). Place, therefore, is not just a location but a site of human experience.

It is no coincidence that the cells responsible for guiding our spatial orientation are referred to as "place cells." Such cells are located in the hippocampus, as discovered by O'Keefe and Nadel in 1978. Place cells allow us to determine our exact position within a spatial field, even when we are not consciously attentive. This neural mechanism plays a critical role in our ability to navigate and understand our environment.

Moreover, research has shown that the brain's parietal cortex integrates sensory information to create a cohesive understanding of spatial relationships. This integration allows us to interact effectively with our surroundings, highlighting the importance of continuous sensory feedback in shaping our spatial awareness (Andersen, 1997). The ventral visual stream, which processes object recognition, also contributes to our spatial understanding by enabling us to identify and navigate around objects in the space (Milner & Goodale, 2006)

Additionally, a further theory explores spatial perception and experience through bodily movements, primarily focusing on proprioception. Studies on dance, for example, reveal how individuals relate to the space through embodied simulation - which is of what they experience, which significantly influences their perception of external space (Departi, Iosa & Haggard, 2009). By means of embodied simulation we do not just 'see' an action, an emotion, or a sensation. Side by side with the sensory description of the observed social stimuli, internal representations of the body states associated with actions, emotions, and sensations are evoked in the observer, as if he/she would be doing a similar action or experiencing a similar emotion or sensation. Mirror neurons are likely the neural correlate of this mechanism (Gallese, 2007). This phenomenon demonstrates that changes in our postures, movements, physical abilities, and emotional reactions to the environment alter our perception of both external space and us (Gallagher, 2005).

Finally, "environment" is a comprehensive term that encompasses both space and place, including the physical, social, and cultural conditions that influence human behavior and experience (Gifford, 2014). The environment is dynamic, subject to continuous change as both natural processes and human activities alter landscapes, climates, and ecosystems. Additionally, social and cultural contexts within an environment evolve over time, influencing how individuals perceive and interact with their surroundings. Understanding the environment in its totality requires considering these ongoing transformations and their impacts on human well-being and societal development.

Many philosophers and social theorists contributed significantly to understanding the relationship between environment and behavior.

Kurt Lewin, a pioneer of social psychology from the Gestalt school, proposed through his *Field Theory* a tripartite model: the psychological fact (the *person*), the environmental and objective fact outside the person (the *environment*), and the boundary zone where psychological and environmental factors intersect in the individual's subjectivity. According to Lewin, each individual exists within a "field" representing their life space, which interacts with surrounding social and environmental facts. The field is defined as a totality of coexisting facts in their interdependence. Lewin emphasized that an individual's perception of themselves and their environment is crucial for understanding *behavior*.

The reciprocal influence between environment and behavior, as outlined by Lewin's theory, has been widely adopted by subsequent perspectives. Experimental studies in social psychology within communities have deepened this relationship, focusing on the specific characteristics of urban environments and their influence on human behavior.

One notable theory is the "broken windows" theory proposed by Zimbardo, Wilson, and Kelling. This theory links the physical appearance of urban spaces with social behavior, suggesting that signs of neglect and decay can foster antisocial and criminal behaviors (Zimbardo, 1969; Wilson & Kelling, 1982). Wilson and Kelling's studies confirmed this theory, demonstrating that a neglected and disorderly environment leads to an increase in deviant behaviors. Their research showed that the presence of graffiti, broken windows, dirt, and other signs of disorder negatively influence people's behavior, contributing to a sense of abandonment and neglect that fosters deviant behaviors (Zimbardo, 1969).

However, understanding how people behave in an architectural space does not elucidate why they behave in that manner. This distinction is closely related to individuals' emotional responses to environments. While personality traits may influence our perception of the environment (Ibrahim et al., 2002), a fundamental aspect of human experience in space is the influence of the spatial properties on our mental state. Visual experiences such as color, contrast, motion, retinal size, location, and object identity elicit emotional responses (Baars, Ramsøy, and Laureys, 2003).

As such, environments, all are perceived not only according to physical features, but also in terms of a person’s affective response towards them.

According to Russell (2003), some form of affective response is always present within an individual, whether perceived as neutral, moderate, or extreme. When affect is in the foreground—due to its intensity or situational cues—it can be consciously experienced as pleasant or unpleasant, forming the basis of an emotional experience (Feldman Barrett et al., 2007; Russell, 2003). Conversely, when affect is milder, it influences conscious experience and behavior in a more indirect manner. In such cases, background affect is perceived as a property of the individual's environment (Russell, 2003; Feldman Barrett et al., 2007). These two affective states—emotions and affective qualities—are prevalent approaches for investigating affective responses to space.

Similarly, although the potential mediating role of affective responses between spatial perception and behavioral outcomes is recognized, scientific evidence lacks a comprehensive and systematic approach in analyzing these responses.

To sum up, understanding the role of the physical environment in shaping perception, affect, cognition and behavior is crucial for developing effective interventions in design for both indoor and outdoor spaces. Investing in creating safe, welcoming, and well-maintained environments can promote psychological individual well-being and improve the quality of life for the community (Zimbardo, 1969; Wilson & Kelling, 1982).

The next paragraph will address specifically the emergence of environmental psychology, which has dedicated itself to explaining all these processes. Drawing upon contributions from various disciplines such as social psychology, neuroscience, and philosophy, the focus of environmental psychology has primarily been to investigate the impact of space on human behavior. While environmental psychology has broadened its scope to cover other dimensions, such as sustainability and the interaction between natural and built environments, its core objective remains to understand how spatial factors influence cognitive, affective and behavioral outcomes. This field continues to explore how different environments, whether urban or natural, aesthetically pleasing or displeasing, affect individuals' perceptions, emotions, and actions, thereby contributing to the design and management of spaces that promote psychological well-being and social cohesion.

5.2 Background: the contribution of Environmental Psychology

On October 28, 1943, during a debate in the House of Commons in London, devastated by the bombings of 1941, Winston Churchill pronounced a phrase that still holds significant relevance today: "*we shape our buildings, and afterwards, our buildings shape us*" (UK Hansard 1943, 403). This statement not only highlights the mutual influence between individuals and physical spaces but also underscores the communicative and symbolic impacts that physical-spatial contexts can have on individuals' psychological responses.

Up to this point, we have discussed "spaces"; however, we will refer to these with a more generic term that encompasses the concept of space while including many other elements already mentioned in the previous paragraph.

The etymology of the term environment reflects its nature of "surrounding" or "going around." From the Latin *ambiens* the participle of *ambire* (to surround, to go around). This meaning is found in other languages as well: in English, environment, from the French *environnement*, a word composed of the prefix *en* (around) and the verb *virer* (to turn); in German, *umwelt*, composed of the prefix *um* preceding the noun *welt* (world), indicating what surrounds; and in Mandarin, *huàn-jìng*, the sum of the words for ring and boundaries.

In the vast landscape of psychology, an area of growing interest is that represented by environmental psychology, which focuses on analyzing the complex interaction between human beings and the surrounding environment. Environmental psychology emerged as a discipline when researchers began to gradually abandon laboratory research, which had previously dominated psychology, to study human behavior in real, more ecological contexts (Levy-Leboyer, 1982; McAndrew, 1993).

Scientific psychology has always concerned the relationship between the individual organism and its context. Specifically, environmental psychology explores the ways in which space influences the psychological development of individuals and, conversely, how environmental characteristics can shape human experiences.

According to Egon Brunswick (1956), who emphasized the importance of research conducted in the subject's natural environment through representative design, environmental factors exert an influence on the individual at an unconscious level. This underscores the importance of understanding the dynamics of the environmental system in which the individual is immersed.

Environmental psychology began to develop in the early 1950s in response to the growing awareness of the impact of the environment (understood in both its natural and artificial aspects) on people's health and psychological well-being (Costa, 2009; Steg, Van del Berg & De Groot, 2013).

In the late 1950s, the term *Environmental Psychology* was coined, shifting the focus from the investigation of the physical characteristics of environments to a broader interest in the interface between human behavior and the socio-physical environment.

Then, it was in the 1960s that a more explicit and official role for the social sciences and psychology applied to the environment emerged, leading to the first interdisciplinary collaborations with various stakeholders such as designers, architects, urban planners, builders, and businesses (Bilotta & Bonaiuto, 2012). The main objective was to develop theoretical models and design interventions to improve environmental quality and promote sustainable practices oriented towards human well-being.

As already mentioned, understanding the relationship between the individual and the environment is based on the ability to observe space not only as a physical context but as an environment rich in cultural and social meanings, influenced by relationships and social dynamics.

The concept of *environmental identity*, proposed by Clayton (2003), offers a deep insight into how space is not only a physical place but also a reflection of individual and collective identity, the result of an identity process of recognition and mirroring. Inhabiting a space thus becomes an experience intrinsically linked to self-perception, interpersonal relationships, and emotions connected to the surrounding environment. We have phylogenetic and ontogenetic preferences for certain types of environments, and at the same time, we actively seek to modify the environment to make it more suitable for us. Consequently, the question of environmental psychology revolves around how it is possible to design or modify the environment to enhance individual well-being, aiming to improve the person-environment relationship based on cognitive, emotional, and general psychological knowledge of how we function.

In line with this perspective, the concept of a *supporting environment* proposed by Canter (1983) highlights the importance of an environment that provides the subject with all the necessary information to facilitate their actions. For an environment to receive a positive affective evaluation, it must present various perceptual aspects, allowing the subject to understand the type of environment they are in and what resources it offers to meet their goals. At the same time, the environment should maintain a certain degree of mystery to arouse interest and stimulate exploration.

Contemporary trends in environmental psychology also outlined the role of specific architectural and design elements both for public and private spaces in harmonizing the environment with human experience and promoting greater psycho-physical well-being (Fornara & Andrade, 2012).

For instance, several studies have shown a direct link between poor architectural design and negative psychological responses (Ricci, 2021) and vice versa (see also Study 1, described in Chapter 3).

Considering that UX results from the interaction between a user and a product within a physical, social, and cultural context, researchers must recognize that users can have different experiences with the same product depending on the context. Therefore, the ability to identify and create suitable contexts presents a significant challenge. Furthermore, it is essential to investigate space both as a contextual element and as an integral component of the user experience. This dual perspective allows for a comprehensive evaluation of how space influences user interactions and perceptions.

In the next paragraph, I will elucidate how the investigation of the environment, both as a contextual element and as an integral part of the UX, can be conducted to enhance our understanding of its impact on the overall experience. This exploration will involve identifying the specific features of the environment that contribute to shaping user perceptions, emotions, and behaviors, ultimately influencing the effectiveness and quality of the user experience.

5.3 The Role of Environment in User Experience

As we have seen, the concept of environment is complex and plays a primary role within UX design, encompassing not only the physical space but also the psychological and emotional contexts in which users interact with artifacts.

While empirical evidence on this subject is limited, this section will examine several pieces of evidence that provide a framework for designing the final study I will present in this thesis.

To my knowledge, there are two models that thoroughly explores spatial dimensions of UX. The former is the IPP (Immersion, Presence, Performance) model (Bystrom et al., 1999) which combines two previous models on presence in virtual environments, one by Barfield and colleagues (Barfield & Hendrix, 1995; Barfield et al., 1997) and the other by Slater and colleague (Slater & Wilbur, 1995). The IPP model describes integrates key components of display technology, immersion, sensory fidelity, attentional resource allocation, and task performance within virtual environments. It begins with the "enabling technology," encompassing various display technologies that define the quantifiable features of the system, such as visual resolution and the degrees of freedom provided by input devices. These technological attributes directly influence the level of immersion, a concept central to the model, by determining the fidelity of sensory information—how closely the virtual environment replicates real-world sensory experiences. Sensory fidelity, in turn, affects the participant's sense of presence within the virtual environment, which is essential for effective interaction and task performance. The model further posits that the allocation of attentional resources by the participant is crucial in fostering this sense of presence. As the participant engages with the virtual environment, the nature of the task and the level of sensory fidelity can create a feedback loop that enhances attentional focus and presence, similar to the dynamics proposed in Csikszentmihalyi's flow theory (1990). Ultimately, the model suggests that a higher sense of presence, influenced by these interconnected components, leads to improved performance in the virtual

environment. The second model is more recent and called SUE (Spatial User Experience) and elucidates the UX resulting from the interaction between users and physical environments. Authors define spaces as *physical settings*, functional systems designed to facilitate specific activities, characterized by environmental conditions, internal elements, and their distribution.

These physical settings can be categorized based on the classification of atmospheric cues proposed by Turley and Milliman (2000), into five groups: (1) *orientation features*, which include layout, placement of critical components, and information about the process associated with the setting; (2) *physical features*, which refer to the physical and anthropometric characteristics of furniture and interactive elements, as well as accessibility conditions; (3) *environmental features*, encompassing lighting, temperature, sounds, noise, air quality, and scents; (4) *aesthetic features*, which pertain to the characteristics of the architecture, design style, ambience, and decoration; and (5) *density*, which refers to the quantity of people or objects within the space (Eroglu, Machleit, & Barr, 2005).

Understanding that individuals interact with physical settings within specific social, cultural, and economic contexts is essential. Each user, with their unique characteristics, personality, and past experiences, approaches a setting with particular goals that the environment should support. According to Carlson (1997), these goals guide human interaction and determine which elements of the environment become salient. Within the SUE model, authors conceptualize goals in terms of the user's state of mind or what Hassenzahl, Kekez, and Burmester (2002) referred to as *usage modes*. Hassenzahl (2003) delineated two usage modes: *goal-mode* and *action-mode*. In goal-mode, users focus on accomplishing their objectives efficiently, treating the product as a means to an end. Conversely, in action-mode, users focus on the interaction itself.

Drawing on this evidence and on the S-O-R model (introduced in Chapter 3), the SUE model comprises two types of responses to spatial stimuli: an *Ergonomic-Instrumental* category of responses, which includes the processes that occur when individuals interact with the environment. Individuals evaluate the compatibility between the characteristics of the setting and their needs. Thus, to become optimal environments, settings should be designed according to human cognitive and physical capabilities and limitations, facilitating the activity and minimizing human error. The dimensions in this category are (1) spatial cognition, (2) physical compatibility, and (3) environmental compatibility. The second type of responses is represented by the *Affective* category, which includes the human processes that occur when individuals interact with the space, influencing the way they feel during the interaction. These processes are informative about the affective state of the user, through emotion, perceptions, and judgments. The dimensions considered in this category are (1) emotional reaction, (2) spatial appreciation, and (3) proxemics.

For the purposes of this thesis, the dimensions of the model that are of primary interest are the aesthetic and affective categories. Specifically, we focus on the aesthetic characteristics of space, which we have operationalized in the final study through the *Visual Design Principles (VDPs)*.

Those principles are a fundamental pillar in the design of user environments and the presentation of artifacts, as they profoundly influence the emotions and individual well-being of users (Menninghaus, 2019; Huang, Lyu, Xiu, & Peng, 2020). These principles, which include *Color, Lighting, Balance and Movement*, are universally

recognized as essential tools for industry experts, enabling the creation of engaging and memorable experiences (Kimball, 2013). Design principles should be used as an initial reference point in conversations between designers and users, guiding the development of initial prototypes that can later be tested with users. The synergistic interaction of these elements contributes to the overall perception of structure and composition, which in turn influences the formation of general emotional valence, which can be either positive or negative (Chatterjee, 2011; Locher et al., 2007; Rasche & Koch, 2002). By strategically utilizing design principles, it is possible to create visually appealing, functional, and effective UX.

I will focus on each visual design principle and review the scientific evidence linking them to positive experiences, drawing primarily from research in psychology and cognitive sciences that has examined their effects.

Color plays a fundamental role in the design and functionality of environments and objects, provided it is used with care and awareness (Costa, 2013). It is not only an aesthetic issue, but it also exerts a profound influence on human emotions and behavior (Elliot & Maier, 2014). This feature not only contributes to visual communication but also has the power to attract attention, set the tone of the message, and guide the observer's eye to specific focal points, influencing up to 90% of product choices.

The *Color Association Theory* suggests that people may unconsciously associate certain colors with specific concepts or feelings, influencing their perceptions and reactions to visual stimuli (Mehta & Zhu, 2009). These associations can vary between cultures and social contexts, contributing to the diversity of color preferences (Elliot & Maier, 2014). Research on color-emotion associations shows that hue, chrominance, and luminance are correlated with different emotional experiences (Pazda, Thorstenson, Christopher & Fetterman, 2024).

The perception of warmth or coolness of colors is subjective and can influence the thermal sensations perceived by the observer (Presti et al., 2022). Studies indicate that cool colors, such as blue and green, tend to be perceived as relaxing, while warm colors, such as red, have a stimulating effect (Ballast, 2002; 2013; Kaya & Epps, 2004). However, the preference between warm and cool colors can vary depending on circumstances and individual preferences. The arrangement and use of colors in environments can influence the psychological perception of spaces (Rodeck et al., 1998). For example, yellow can stimulate, orange can encourage movement, while purple can evoke a sense of insecurity.

Furthermore, colors can serve different functions depending on their placement, as highlighted by Mahnke (1996). Saturated colors are ideal for capturing attention and expressing excitement and dynamism, although they may become tiring over the long term (Costa, 2013). On the other hand, desaturated and bright colors are perceived as friendly and warm, while desaturated and dim colors are associated with a sense of seriousness and professionalism.

Color preferences tend to be influenced by the individual's psychological state (Costa, 2013). For example, immersion in red environments can improve performance in detail-oriented cognitive tasks, while blue spaces might be associated with improved creative thinking (Mehta & Zhu, 2009).

As for *Lighting*, evidence from environmental psychology has highlighted that the arrangement and quality of light can influence individuals' attention and concentration. Light structures the sense of immersion, affecting the material qualities of the environment (Mallgrave, 2015).

Light refers to the relative brightness and darkness, perceived in terms of varying levels of contrast, determining the light or dark appearance of an area.

For example, central lighting (in the center of the space, focused on the main area) tends to direct the observer's attention outward, highlighting only particular elements or areas, while peripheral lighting (creating a more intimate atmosphere from sources positioned in the corners) promotes internal concentration (Stamps, 2002). The level of arousal can be modulated by the amount of light penetrating through windows, supporting circadian rhythms and contributing to general well-being. Additionally, the relative illumination created within the virtual architectural environment contributes to creating the illusion of place, enhancing immersion and consequently modulating affective states (Presti et al., 2022). Research conducted by Cruz-Neira and colleagues (1993) has shown that modulation of virtual lighting can enhance the sense of presence and immersion of users in virtual environments.

Thirdly, *Balance* plays an essential role in creating engaging and harmonious visual experiences (Kimball, 2013), contributing to a positive aesthetic preference (Wilson & Chatterjee, 2005). It refers to the visual placement or distribution of objects in a composition, providing a visual representation of a sense of equality. This can be achieved through a symmetrical or asymmetrical composition to create a relationship of strength among the various represented elements, either to balance or to imbalance the composition. Symmetrical balance occurs when elements are evenly arranged on both sides of an axis.

Studies based on the implicit association test (IAT) correlated the perception of symmetrical elements with positive words such as "love" and asymmetry with negative words such as "hate" (Wang & Hsu, 2020). These results indicate that visual symmetry can trigger a positive response in individuals, although it has to demonstrated it this response is also on an affective nature.

Additionally, balance can be achieved not only through symmetry but also through the visual arrangement of elements in a composition. Balanced compositions can create a sense of stability and harmony, while unbalanced compositions can generate tension (Kimball, 2013).

Finally, the concept of *Movement* refers to the ability to suggest dynamism through various visual elements, representing one of the most powerful stimuli for capturing attention and arousing interest in environments. Dynamism can be defined as attributing a sense of movement to an image that is itself static (Cataldo, 2010).

Interior environments with more linear geometries produce less pleasure and excitement in subjects. Studies in the field of neuroaesthetics have highlighted a preference for curvilinear spatial elements over more linear geometries (Gomez-Puerto, Munar, & Nadal, 2016). It has been observed that judgments of pleasure and excitement are lower in environments with more linear geometries, accompanied by decreased activity in the anterior cingulate cortex (ACC) (Banei, Yazdanfar, Hatami, & Gramann, 2017). Further research has confirmed that spaces characterized by dynamic lines and shapes can increase users' attention and engagement, thereby contributing to a better experience (Tang & Wang, 2019). Additionally, the contour of a visual object, whether

it presents sharp or curved angles, significantly influences people's attitudes toward that object. It has been observed that objects with predominantly sharp features and acute angles are generally less liked and evoke fewer emotional reactions compared to corresponding objects with curved contours. The hypothesis underlying the study is that sharp transitions in a contour could convey a sense of danger or unconscious threat, thereby triggering a negative bias (Bar & Neta, 2006). This phenomenon can be better understood by considering curvilinearity as one of the primitive aesthetic principles. Aiken (1998) suggests that curved forms, being more frequently found in nature, tend to be perceived as safer and more pleasant compared to angular and jagged forms, which may evoke an alert or danger response.

In natural environments, dangerous objects like thorns and sharp teeth often feature angular contours. As a result, our brains may have evolved to recognize these shapes as potential threats. On the other hand, curved shapes, which are less frequently linked to danger, tend to elicit a more positive emotional response.

Building on these insights, the following study delves into the specific ways in which visual design parameters (VDP), such as color, lighting, balance, and movement, influence visitor experiences in virtual environments. By examining these elements systematically, the study provides valuable insights into how environmental features can be optimized to enhance both emotional and aesthetic responses.

5.3.1 Study 4: The Impact of Spatial Design Elements on Emotional and Aesthetic Responses in a Virtual Museum

5.3.1.1 Aim

The primary objective of this exploratory study is to assess the impact of each VDP on the Visitor Experience. The study considers four main design features described by VDP: *Color*, *Lighting*, *Balance*, and *Movement*. These features were operationalized in eight distinct Virtual Reality Environments (VREs) and systematically represented and manipulated so that each environment was characterized by one of the polarized features (warm vs. cold colors, bright vs. dark lighting, symmetrical vs. asymmetrical balance, high vs. low dynamism). For simplicity, these VREs will be referred to as *Warm, Cold, Bright, Dark, Symmetrical, Asymmetrical, Dynamic, and Static*, and each pair of VREs will be referred as "block".

The primary objectives of this exploratory study include analyzing the differential impact of the two polarized versions of each VDP on the Visitor Experience. This analysis will examine both affective responses (such as levels of pleasure, arousal, and perception of control) and aesthetic perceptions (including attraction, pleasure, stimulation, contentment, perception, intention, immersion, and information load). Additionally, the study seeks to identify the preferred VRE among the eight tested environments based on these dimensions.

5.3.1.2 Methodology

5.3.1.2.1 Creation of the stimuli (VREs)

Eight Virtual Reality Environments (VREs) were created using Unity 2023.2.15 software in collaboration with professional developers from Studio Volpi, an italian company specializing in design concepts, technology and innovation, UX and UI development, branding, and communication. These environments were developed from a pre-defined VRE of reference, representing a virtual art gallery characterized by design furnishings. Paintings on the walls from various artists and artistic movements were displayed on the walls. Such space was chosen as stimulus due to its suitability for thoroughly investigating complex aesthetic and emotional experiences. The museum-like environment provides a rich, multisensory context, making it ideal for in-depth exploration of user interaction with spatial design.

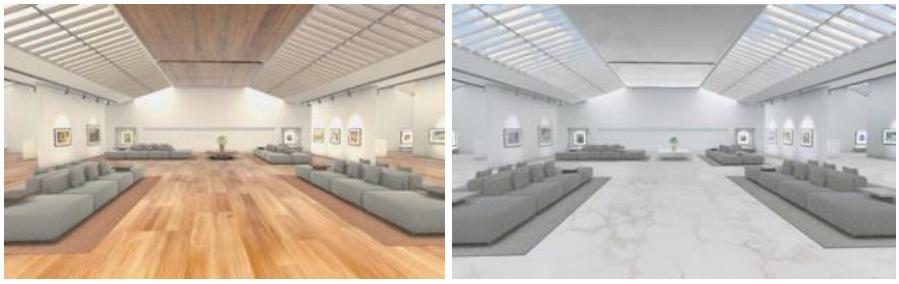
Through active consultation with developers and field professionals, including digital project managers, designers, and architects, each VRE was designed to prominently feature one of the four selected design features. These characteristics were manipulated and polarized towards their two extremes, while maintaining other variables of interest as possibly neutral. The following table details each VDP (Design Feature), the composition of each block of VREs, with an appropriate description of how it was represented and operationalized within each environment (Table 10). This ensured that the environments effectively communicated the impacts of VDPs clearly and coherently.

Table 10: This table details the composition and design descriptions of the various blocks of Virtual Reality Environments (VREs) used in the study. The design features (VDPs) include Color, Lighting, Balance, and Movement, each with specific levels that create distinct environmental characteristics.

VDP (Design Feature)	**Composition of each block of VREs (Level of the Design Feature)**	**Description of the design of each block of VREs**
Color	Warm vs. Cold	Presence of "warm" or “cold” colors. Walls and floors are enriched with warm tones obtained through a combination of brown and orange shades, accompanied by wooden textures; walls and floors are represented with different shades of gray and blue, with a metallic texture and marble floors to accentuate cool tones. (Figure 7a)

Lighting	Bright vs. Dark	Presence of diffuse light makes the environment "bright"; presence of soft light makes the environment "dark". The environment is characterized as dark due to weak light sources and dark colors giving a twilight feel. Light is limited through closed windows, with weak internal light sources mainly on the paintings. Conversely, diffuse light makes the environment bright, with significant brightness from external and internal light sources, including lights on paintings and beams from above. (Figure 7b)
Balance	Symmetrical vs. Asymmetrical	The presence of two mirrored halves makes the environment "symmetrical"; absence of this characteristic makes it "asymmetrical". The environment is symmetrical due to the perfect arrangement of sofas in two mirrored halves within the room; conversely, the lack of such mirrored arrangement makes the environment asymmetrical, with sofas arranged without a clear division of space. (Figure 7c)
Movement	Dynamic vs. Static	Presence of curvilinear, sinuous, and rounded elements makes it “dynamic”; presence of squared/linear elements makes the environment “static”. The perception of stillness is evident in sofas with sharp corners and rectangular tables, and with straight and linear flower vases; in contrast, curvilinear sofas, round tables, and rounded supports contribute to the perception of dynamism. (Figure 7d)

a)



b)

c)

d)

Figure 7: The figure illustrates the eight VREs (Warm, Cold (a); Bright, Dark (b); Symmetrical, Asymmetrical (c), Dynamic, Static (d) used as stimuli.

5.3.1.2.2 Experimental Design

The study employs a *within-subjects* design, with all participants exposed to all eight VREs. These VREs are divided into four blocks, each containing two VREs (reflecting the 8 total levels of the variables: 2 levels for each of the 4 variables/design features—Color, Lighting, Balance, Movement.

5.3.1.3 Instruments

5.3.1.3.1 Self-report Questionnaires

Pre-Experimental Questionnaire

The pre-experimental questionnaire, completed on the day of the experiment, included the informed consent and personal data processing form, and comprised several scales aims at measuring:

Trait variables:

- Dispositional Positive Emotion Scale (DPES) - awe subscale - (Chirico, Shiota, & Gaggioli, 2021): This scale measures the disposition towards the positive emotion of awe through 6 items. Each item is rated on a 7-point scale from 1 (extremely disagree) to 7 (extremely agree). For all subscales of the Disposition for Positive Emotion scale, the minimum possible score is 0. The maximum possible score for the Joy, Love, and Awe subscales is 42, while for all other subscales it is 36.
- Desire for Aesthetics Scale (DFAS) (Lundy et al., 2010): This scale, consisting of 36 items, measures individual differences in aesthetic interest. Each item is rated on a 6-point Likert scale from 1 (not at all) to 6 (very much). The minimum possible score on this initial 36-item DFAS is 0, and the maximum possible score is 240. A completely neutral score would be 120, and higher scores indicate a greater desire for aesthetics in daily life.

State variables:

- Positive and Negative Affect Schedule Short-Form (PANAS SF) (Terraciano, 2003): This scale measures positive and negative affective states through 10 adjectives, with 5 related to positive emotional states and 5 to negative states. Each item is rated on a 5-point scale from 1 (not at all) to 5 (very much).

Post-Experimental Questionnaire

The post-experimental questionnaire, completed after viewing each block of VRE, included:

- *Self-Assessment Manikin (SAM)* (Bradley & Lang, 1994): This consists of three 9-point graphic scales to assess pleasure (emotional state from 1-unpleasant to 9-pleasant), arousal (emotional activation level from 1-calm to 9-activated), and dominance (perceived control over the environment). The different points on the scales are represented by stylized figures whose expressions indicate positive or negative emotions, calmness or activation, and high or low control. Participants mark the figure that best represents their feelings in response to each stimulus, with the option to choose intermediate positions.

- *Ad-hoc items to assess aesthetic/perceptual, affective and cognitive variables* related to UX in interacting with spaces (adapted and translated from Cho & Kim 2017), rated on a 5-point scale from 1 (not at all) to 5 (very much).

- *Attraction* (Item 1, 2): "I like the design of the environment."; "I like the atmosphere."
- *Pleasure* (Item 3): "The environment makes me feel happy."
- *Stimulation* (Item 4): "The environment stimulates my interest."
- *Content* (Item 5): "I think the environment conveys a message."
- *Perception* (Item 6, 7): "Space stimulates senses other than sight."; "The design of the space is multisensory."
- *Intention* (Item 8): "The space is well designed to fit its purpose."
- *Configuration* (Item 9): "All elements are well arranged within the space."
- *Immersion* (Item 10): "I would have liked to stay longer in the space."
- *Information load* (Item 11): "I was satisfied with the amount of environmental information present in the space."

At the end of the questionnaire, for each couple of VREs, an open-ended question was included to investigate which specific design feature the participant perceived as altered in the two VREs.

5.3.1.4 Procedure

On the day of the experimental intervention, participants were welcomed in a room at the Department of Psychology at the Catholic University of the Sacred Heart, specifically set up for the experimental session. Before the experimental session, participants signed the informed consent form and completed a pre-experimental baseline questionnaire administered via *Qualtrics*.

Before immersion in the VREs, participants received detailed instructions on how to wear and use the VR HMD (Head-Mounted Display). They were told they could only move forward with the controllers (without being able to turn left or right) and to freely move their gaze, to explore each VRE for approximately 1.30 minutes. Additionally, they were informed that in case of adverse reactions to VR, they could stop the experience at any time.

After wearing the HDM, participants were exposed to the eight VREs, divided into four blocks, each containing two VREs.

The order of the blocks and the internal order of the VREs was randomized but each block consistently contains the two polarized versions of the same VDP. Each block lasted no more than three minutes, resulting in a total exposure time to the VREs of up to 12 minutes for the four blocks. The choice to present two VREs at a time was made to allow a more accurate retrospective, emotional, and perceptual evaluation by participants regarding

the just-viewed stimuli, and to enable participants to take multiple breaks between each block to avoid symptoms of fatigue and exhaustion due to VR. During these breaks, participants removed the HMD and were invited to complete a post-experimental questionnaire on the block of VREs just observed, for a total of 4 post-questionnaire. The duration of the questionnaire after each block was approximately five minutes.
The "pairwise" presentation of environments was useful to implicitly make the polarized characteristic evident to participants within each block without revealing it at the beginning of each block presentation.
The entire experimental procedure, including questionnaire completion, lasted between 35 and 45 minutes. At the end of the experimental procedure, a brief debriefing was conducted. Finally, participants were thanked and dismissed.

5.3.1.5 Ethical Approval

Prior to data collection, the experimental protocol was approved by the Ethical Committee of the Università Cattolica del Sacro Cuore (Protocol Rf. number:40/24). Each participant provided written informed consent for study participation. Written consent and all methods were carried out in accordance with the Helsinki Declaration.

5.3.1.6 Data Analysis

Data analyses were performed through the statistical software IBM SPSS 23.0 and R programming language (version 4.2.3) with the 'ordinal' package (version 2023.12-4) for conducting the Cumulative Link Mixed Models (CLMM) developed by Christensen (2023).

5.3.1.7 Results

5.3.1.7.1 Sample Description

A total of 47 participants (12 men and 35 women) were recruited for the study, with most women (72.3%) aged between 19 and 58 years (M= 25.72; SD= 7.52). The estimated sample size for the study was 36 participants (calculated with G-power, v. 3.1.9.7). An alpha error of .05 and a power of .95 were assumed for a repeated measures ANOVA model with eight measurements (number of experimental stimuli). Based on the literature, an effect size of .20 was estimated. Therefore, the obtained sample size of N=47 is adequate to test the study hypothesis.

5.3.1.7.2 Preliminary Check

Normality of the data was assessed using the Shapiro-Wilk test, revealing that all variables except for DPES and DFAS did not follow a normal distribution.
Table 11 presents the descriptive statistics for the trait and state variables measured at the baseline. The mean (M) and standard deviation (SD) are reported for each variable, including the Positive Affect and Negative Affect scales of the PANAS, the overall score of the DFAS, and the awe subscale of the DPES.

Table 11: Descriptive statistics related to PANAS (Positive and Negative dimensions) to DPES (awe subscale) and DFAS scale.

	Mean (M)	**SD (Standard Deviation)**
PANAS POS	3.04	.80
PANAS NEG	1.39	.53
DFAS	144.23	15.78
DPES awe subscale	4.56	.87

5.3.1.7.3 Model and Analysis Explanation (Random, Fixed Effects and Post-Hoc Analyses)

The analyses were conducted using *Cumulative Link Mixed Models* (CLMM) to assess the effects of the four VDPs, generally, and for each version of each VDP, on affective responses, measured through SAM and aesthetic ones, measured through 11 ad-hoc items. For simplicity, I will refer to each VDP as *Design Feature* (Color, Lighting, Balance, Movement) and to the two versions of each VDP as *Level 1 and Level 2* (Warm, Cold, Bright, Dark, Symmetrical, Asymmetrical, Dynamic, Static).

I choose CLMM because this model is particularly suitable for these ordinal response data as it allows for the incorporation of both fixed and random effects, thus accounting for the nested structure of our design where scenarios are nested within design features. This model helps in evaluating the ordinal nature of the response variables while considering the potential correlations within subjects.

Ordered regression models, such as CLMM, are an alternative for ordinal outcomes compared to linear regression models, which impose the unrealistic assumption of equal spacing between categories, and binary regression models, which require arbitrarily collapsing categories and potentially losing valuable information (see Fullerton & Anderson, 2021). CLMMs maintain the ordinal integrity of the data by using a logit link function to model the cumulative probabilities of the response categories. In this study, the dependent variables are affective and aesthetic responses, respectively assessed on a Likert scale, for SAM from 1 to 9 and for ad hoc items from 1 to 5. These variables include *Pleasure, Arousal, Dominance* as dimensions of SAM and *Attraction, Pleasure, Stimulation, Contents, Perception, Intention, Configuration, Immersion, and Information Load* as dimensions related to aesthetic perceptions. Each of these variables represents ordinal data with multiple ordered categories. The independent variables include *Design Feature* (with four levels representing different VDPs) and *Level* (with two levels, Level 1 and Level 2, for each design).

The model converged successfully after 1619 iterations (total evaluations: 6478) with a maximum gradient of 2.48e-04 and a condition number of 2.2e+02. The model's log-likelihood was -603.38, and the AIC was 1240.75, indicating an adequate fit. As for Random Effects, the variance of the random intercept for "id"**,** which represent each participant of the study**,** was 0.9169 with a standard deviation of 0.9575, suggesting considerable variability between subjects. The Fixed Effects represent the average change in the dependent variables for each level of Design Feature and Degree compared to their respective reference categories, holding all other variables constant. In these models, Design Feature 1 serves as the reference category for Design feature, and Level 1 serves as the reference category for Level. For example, considering the results for the second Design Feature, i.e., Lighting, the estimate for this feature indicates how much the dependent variable increases or decreases, on average, relative to the Design Feature 1 (i.e., Colors), holding Degree constant.

5.3.1.7.4 Self-Assessment Manikin (SAM)

The analysis of SAM Pleasure revealed significant main effects for Lighting (Estimate = 0.836, SE = 0.381, z = 2.197, p = 0.028), Movement Design features (Estimate = 0.783, SE = 0.371, z = 2.109, p = 0.035), and Level 2 (Estimate = 2.259, SE = 0.396, z = 5.707, p < 0.001). These results indicate that higher lighting intensity, dynamic movement, and the context of Level 2 independently increased pleasure ratings. However, significant interactions were found between Level 2 and both Lighting (Estimate = -2.137, SE = 0.552, z = -3.870, p < 0.001) and Movement (Estimate = -1.257, SE = 0.531, z = -2.368, p = 0.018). These interactions suggest that while Level 2 increased pleasure overall, it moderated (and in some cases reduced) the positive effects of lighting and movement. Post hoc comparisons provided further insights into these effects. For example, warm colors (Level 1) scored significantly higher in pleasure (M = 7.51, SD = 1.04) compared to cold colors (Level 2, M = 5.98, SD = 1.70). Similarly, symmetrical designs at Level 1 (M = 7.13, SD = 1.10) yielded higher pleasure ratings compared to asymmetrical designs at Level 2 (M = 6.13, SD = 1.75). Finally, dynamic movement designs at Level 1 (M = 7.00, SD = 1.22) were rated more pleasurable than static designs at Level 2 (M = 6.30, SD = 1.41). These findings highlight the nuanced role of Level 2 as both an enhancer of pleasure and a moderator of the effects of specific design features (see Table 12 for all the values).

For SAM Arousal, no significant main effects or interactions were observed ($p > 0.05$), indicating that neither lighting, movement, nor Level 2 substantially influenced arousal levels. This suggests that arousal might not be a primary factor affected by these design features in the tested contexts.

The analysis of SAM Dominance revealed a significant main effect of Level 2 (Estimate = -1.239, SE = 0.373, z = -3.322, $p = 0.001$), with dominance scores decreasing in Level 2 contexts compared to Level 1. Post hoc comparisons showed significant differences within Color and Balance Design features. Specifically, warm colors (Level 1, M = 5.74, SD = 2.10) elicited higher dominance ratings than cold colors (Level 2, M = 4.70, SD = 1.99), and symmetrical designs (Level 1, M = 5.83, SD = 2.09) were associated with higher dominance ratings than asymmetrical designs (Level 2, M = 4.68, SD = 1.99).

These findings collectively suggest that Level 2 exerts a complex influence on pleasure and dominance: while it independently enhances pleasure, it moderates and sometimes reduces the positive effects of specific design features like lighting and movement.

3.3.1.7.5 Ad-hoc items to assess aesthetic/perceptual, affective and cognitive variables related to UX in interacting with spaces

For Attraction, significant main effects were found for Lighting Design feature (Estimate = -0.830, SE = 0.384, z = -2.163, p = 0.031) and Level 2 (Estimate = -1.995, SE = 0.387, z = -5.155, p < 0.001), along with a significant interaction between Lighting and Level 2 (Estimate = 2.335, SE = 0.553, z = 4.221, p < 0.001). These results suggest that while Level 2 decreased overall attraction scores, its interaction with lighting created specific contexts in which attraction increased. Post hoc analyses revealed significant differences between Level 1 and Level 2 for Color, Balance, and Movement Design features. Warm colors (Level 1, M = 4.12, SD = 0.82) were rated as more attractive than cold colors (Level 2, M = 3.13, SD = 1.07), and symmetrical designs (Level 1, M = 3.96, SD = 0.63) were rated higher than asymmetrical ones (Level 2, M = 3.15, SD = 1.14) (see Table 12 for all the values).

For Pleasure significant main effects were found for Lighting (Estimate = -1.180, SE = 0.391, z = -3.023, p = 0.003), Balance (Estimate = -0.763, SE = 0.378, z = -2.021, p = 0.043), Movement (Estimate = -0.892, SE = 0.388, z = -2.303, p = 0.021), and Level 2 (Estimate = -2.397, SE = 0.405, z = -5.927, p < 0.001). Significant interactions were observed with Lighting (Estimate = 2.121, SE = 0.562, z = 3.776, p < 0.001), Movement (Estimate = 1.220, SE = 0.544, z = 2.244, p = 0.025), and Balance (Estimate = 1.604, SE = 0.543, z = 2.952, p = 0.003). Post hoc analyses indicated significant differences between Level 1 and Level 2 within Color, Balance and Movement Design features (see Table 12 for all the values).
For Stimulation, significant main effects were found for Lighting (Estimate = -0.862, SE = 0.398, z = -2.169, p = 0.030) and Level 2 (Estimate = -1.915, SE = 0.401, z = -4.778, p < 0.001), with a significant interaction between Lighting and Level 2 (Estimate = 2.227, SE = 0.581, z = 3.835, p < 0.001). Post hoc tests revealed significant differences between Level 1 and Level 2 within Color, Balance and Movement Design features (see Table 12 for all the values).

The variable Contents showed no significant main effects or interactions, indicating no substantial differences across both the Design Features and Levels. For Perception, a significant negative main effect of Lighting was observed (Estimate = -0.898, SE = 0.374, z = -2.397, p = 0.016). Post hoc analyses showed significant differences between Level 1 and Level 2 within Color and Movement Design features (see Table 12 for all the values).
Intention analysis revealed a significant negative main effect of Level 2 (Estimate = -1.503, SE = 0.397, z = -3.782, p < 0.001) and a significant interaction with Lighting Design feature 2 (Estimate = 1.561, SE = 0.574, z

= 2.721, p = 0.007). Post hoc analyses indicated significant differences between Level 1 and Level 2 within Color, Balance and Movement Design features (see Table 12 for all the values).

For Configuration, no significant main effects were observed, but a significant interaction between Balance and Level 2 was found (Estimate = -2.354, SE = 0.592, z = -3.979, p < 0.001). Post hoc comparisons showed significant differences between Level 1 and Level 2 within Balance and Movement Design features (see Table 12 for all the values). Immersion showed a significant negative main effect of Level 2 (Estimate = -1.293, SE = 0.387, z = -3.341, p = 0.001), with a significant interaction with Lighting (Estimate = 1.441, SE = 0.557, z = 2.587, p = 0.010). Post hoc tests indicated significant differences between Level 1 and Level 2 within Color, Balance and Movement Design features (see Table 12 for all the values).

Lastly, the analysis for Information Load showed a significant negative main effect of Level 2 (Estimate = -0.818, SE = 0.403, z = -2.029, p = 0.043) and a significant interaction with Lighting (Estimate = 1.203, SE = 0.581, z = 2.069, p = 0.039). Post hoc comparisons revealed significant differences between Level 1 and Level 2 within Color, Balance and Movement Design features (see Table 12 for all the values).

Table 12: The table summarizes the significant main effects, interactions, post hoc comparisons and associated M and SD, for each dependent variable considered, based on CLMM analysis.

Dependent Variable	**Significant Main Effects (with respect to Design Feature 1 and Level 1)**	**Significant Interactions**	**Significant Post Hoc Comparisons (Level 1 vs. Level 2)**	**Associated Mean (M) And Standard Deviations (SD)**
SAM pleasure	Lighting (0.836, p = 0.028), Movement (0.783, p = 0.035), Level 2 (2.259, p < 0.001)	Lighting*Level 2 (-2.137, p < 0.001), Movement*Level 2 (-1.257, p = 0.018)	Color (-2.259, p < 0.001), Balance (-1.421, p < 0.001), Movement (-1.002, p = 0.007)	Color (Warm) (M = 7.51, SD = 1.04) Color (Cold) (M = 5.98, SD = 1.70) Balance (Symmetrical) (M = 7.13, SD = 1.10) Balance (Asymmetrical) (M = 6.13, SD = 1.75) Movement (Dynamic) (M = 7.00, SD = 1.22) Movement (Static) (M = 6.30, SD = 1.41)
SAM arousal	None	None	None	/
SAM dominance	Level 2 (-1.239, p = 0.001)	None	Color (1.239, p < 0.001), Balance (1.215, p = 0.002)	Color (Warm) (M = 5.74, SD = 2.10) Color (Cold) (M = 4.70, SD = 1.99) Balance (Symmetrical)

				(M = 5.83, SD = 2.09) Balance (Asymmetrical) (M = 4.68, SD = 1.99)
Attraction	Lighting (-0.830, p = 0.031), Level 2 (-1.995, p < 0.001)	Lighting (2.335, p < 0.001)	Color (1.995, p < 0.001), Balance (1.324, p < 0.001), Movement (1.124, p = 0.002)	Color (Warm) (M = 4.12, SD = .82) Color (Cold) (M = 3.13, SD = 1.07) Balance (Symmetrical) (M = 3.96, SD = .63) Balance (Asymmetrical) (M = 3.15, SD = 1.14) Movement (Dynamic) (M = 3.80, SD = .96) Movement (Static) (M = 3.25, SD = .93)
Pleasure	Lighting (-1.180, p = 0.003), Balance (-0.763, p = 0.043), Movement (-0.892, p = 0.021), Level 2 (-2.397, p < 0.001)	Lighting (2.121, p < 0.001), Balance (1.220, p = 0.025), Movement (1.604, p = 0.003)	Color (2.397, p < 0.001), Balance (1.178, p = 0.002), Movement (0.794, p = 0.035)	Color (Warm) (M = 3.96, SD = .86) Color (Cold) (M = 2.81, SD = 1.06) Balance (Symmetrical) (M = 3.64, SD = .79) Balance (Asymmetrical) (M = 3.02, SD = 1.09) Movement (Dynamic) (M = 3.57, SD = .93) Movement (Static) (M = 3.17, SD = .79)
Stimulation	Lighting (-0.862, p = 0.030), Level 2 (-1.915, p < 0.001)	Lighting (2.227, p < 0.001)	Color (1.915, p < 0.001), Balance (1.217, p = 0.002), Movement (1.159, p = 0.003)	Color (Warm) (M = 3.97, SD = .67) Color (Cold) (M = 3.08, SD = 1.00) Balance (Symmetrical) (M = 3.83, SD = .64) Balance (Asymmetrical) (M = 3.21, SD = 1.10) Movement (Dynamic) (M = 3.70, SD = .93) Movement (Static)

				(M = 3.21, SD = .83)
Contents	None	None	None	None
Perception	Level 2 (-0.898, p = 0.016)	None	Color (0.898, p = 0.016), Movement (0.879, p = 0.019)	Color (Warm) (M = 3.45, SD = .79) Color (Cold) (M = 3.08, SD = 0.75) Movement (Dynamic) (M = 3.36, SD = .77) Movement (Static) (M = 3.06, SD = .76)
Intention	Level 2 (-1.503, p < 0.001)	Lighting (1.561, p = 0.007)	Color (1.503, p < 0.001), Balance (2.214, p < 0.001), Movement (1.406, p = 0.004)	Color (Warm) (M = 3.94, SD = .79) Color (Cold) (M = 3.28, SD = .99) Balance (Symmetrical) (M = 3.89, SD = .60) Balance (Asymmetrical) (M = 2.74, SD = 1.13) Movement (Dynamic) (M = 3.87, SD = .77) Movement (Static) (M = 3.19, SD = 1.03)
Configuration	None	Balance (-2.354, p < 0.001)	Balance (3.014, p < 0.001), Movement (1.127, p = 0.005)	Balance (Symmetrical) (M = 3.98, SD = .80) Balance (Asymmetrical) (M = 2.52, SD = 1.11) Movement (Dynamic) (M = 3.87, SD = .78) Movement (Static) (M = 3.35, SD = .95)
Immersion	Level 2 (-1.293, p = 0.001)	Lighting (1.441, p = 0.010)	Color (1.293, p = 0.001), Balance (1.287, p = 0.001), Movement (1.166, p = 0.002)	Color (Warm) (M = 3.40, SD = 1.06) Color (Cold) (M = 2.72, SD = 1.14) Balance (Symmetrical) (M = 3.40, SD = .77) Balance (Asymmetrical)

				(M = 2.70, SD = 1.21) Movement (Dynamic) (M = 3.28, SD = .95) Movement (Static) (M = 2.68, SD = 1.04)
Information load	Level 2 (-0.818, p = 0.043)	Lighting (1.203, p = 0.039)	Color (0.818, p = 0.043), Balance (1.862, p < 0.001), Movement (1.204, p = 0.003)	Color (Warm) (M = 3.83, SD = .94) Color (Cold) (M = 3.53, SD = .95) Balance (Symmetrical) (M = 3.89, SD = .76) Balance (Asymmetrical) (M = 3.13, SD = 1.01) Movement (Dynamic) (M = 3.83, SD = .82) Movement (Static) (M = 3.36, SD = .87)

5.3.1.8 Discussion

The primary objective of this study was to assess the impact of four Visual Design Principles (VDPs) on affective and aesthetic dimensions within eight different Virtual Reality Environments (VREs) designed to represent the two polarized versions of each VDP (i.e., Warm vs. Cold Colors, Bright vs. Dark Lighting, Symmetrical vs. Asymmetrical Balance, Dynamic vs. Static Movement).

Overall, the results highlight the significant influence of Lighting, Movement, and Balance design features on user experience, particularly at Level 1. Level 2, while having notable effects, often showed interactions that mitigated the main effects of these features. Warm colors, symmetrical balance, and dynamic movement designs consistently outperformed their counterparts in terms of Pleasure, Stimulation, Attraction, and Immersion. However, the lack of significant effects for SAM Arousal and Contents suggests that not all aesthetic or perceptual dimensions are equally impacted by these features. The interplay between design features and Levels underscores the nuanced dynamics of UX, suggesting that optimal design strategies should account for both the contextual and interactive effects of these variables.

In the following sections I will summarize and discuss the main results separately, respectively related to affective and aesthetic responses.

5.3.1.8.1 Affective responses

Significant results were found for SAM Pleasure and Dominance dimensions. The results for SAM Pleasure indicate that, overall, Lighting and Movement Design features have significant main effects, suggesting that they generally impact pleasure more than the Color feature when all levels are considered together. However, the “direction” of this impact is negative, as indicated by the interaction effect with Level 2. This suggests that both Dark and Static VREs Design Features significantly decrease the pleasurable experiences of these environments. Additionally, analyzing the comparison within each block of VREs, representing each VDP, results showed that Warm, Symmetrical, Dynamic VREs were significantly preferred over their counterparts. This finding is consistent with previous literature in the field. For instance, warm colors are often associated with positive emotions and higher levels of pleasure (Elliot & Maier, 2014). Symmetry in design is known to enhance aesthetic appreciation and evoke positive emotional responses (Wang & Hsu, 2020). Moreover, dynamic elements in an environment are linked to increased engagement and positive affective states (Tang & Wang, 2019). These studies collectively support findings, showing that Warm, Symmetrical, and Dynamic VREs are more pleasurable. For the Dominance dimension, which can be described as the perception of control over the felt emotional state, the negative impact of Level 2 on SAM Dominance showed that VREs characterized by cold colors, darkness, asymmetry, and minimal movement significantly reduce users' perceptions of dominance compared to their opposites. Previous literature also supports this finding. Cold colors, such as blue and green, tend to create calming but less assertive environments (Ballast, 2013; Kaya & Epps, 2004). Soft lighting (dark environment) can decrease the sense of clarity and control, as it makes spaces feel less defined and more diffused (Presti et al., 2022). Asymmetrical designs often evoke a sense of instability and unpredictability, which can undermine feelings of dominance (Rodeck et al., 1998). Minimal movement in an environment can make it feel static and passive, further reducing the sense of control (Banei et al., 2017). The lack of significant findings for Arousal could be attributed to the initial "wow effect" that virtual environments tend to elicit in users. This initial response can create a heightened level of arousal across all environments, effectively flattening the arousal response and making it difficult to discern differences between the various design features. The immersive and novel nature of virtual reality can induce a baseline level of arousal that overshadows more subtle variations induced by specific environmental characteristics, thus masking potential differences that might otherwise emerge in less stimulating contexts.

5.3.1.8.2 Aesthetic responses

The analysis of various aesthetic dimensions, including Attraction, Pleasure, Stimulation, Perception, Intention, Configuration, Immersion, and Information Load, reveals complex interactions between design features and environmental levels that significantly influence the Visitor Experience. Overall, Lighting and Movement Design features consistently show significant main effects, suggesting that they generally have a greater impact on these dimensions compared to Color when all levels are considered together. Specifically, the negative

impact of Level 2, characterized by cold colors, partial darkness, asymmetry, and minimal movement, suggests that these environments are generally less attractive, pleasurable, stimulating, and immersive. This finding aligns with previous research indicating that their counterparts, warm colors, well-lit environments, and dynamic design elements are perceived more positively (Elliot & Maier, 2014; Ballast, 2013; Tang & Wang, 2019). Moreover, the preference for warm, symmetrical, and dynamic environments across various dimensions, as evidence by post-hoc comparisons, underscores the critical role of these features in creating aesthetically pleasing and engaging spaces. Symmetry is known to enhance aesthetic appreciation and evoke positive emotional responses, while dynamic elements in an environment are linked to increased engagement and positive affective states (Wang & Hsu, 2020; Tang & Wang, 2019). For Attraction, the significant main effects and interactions indicate that cold, dark, and asymmetrical environments are less attractive, but effective lighting can counteract these negative perceptions. This is consistent with findings that suggest such environments can evoke feelings of discomfort and lack of engagement (Rodeck et al., 1998; Banei et al., 2017). For Pleasure, the significant negative impacts of Level 2 and the positive effects of Lighting, Balance, and Movement emphasize the need for balanced and dynamic designs to create pleasurable experiences (Gomez-Puerto, Munar, & Nadal, 2016).

In terms of Stimulation, the significant main effects and interactions with Lighting suggest that dynamic and well-lit environments are more stimulating, supporting the notion that environmental factors such as lighting play a crucial role in enhancing user engagement (Mallgrave, 2015). For Perception, the negative main effect of Lighting highlights the importance of adequate lighting for maintaining high perceptual and cognitive performance. Post hoc analyses showing significant differences between Level 1 and Level 2 within Color and Movement Design features suggest that cold, asymmetrical environments reduce perceptual quality, while effective lighting and dynamic elements can enhance it. For Intention, the significant negative main effect of Level 2 and its interaction with Lighting indicate that environments characterized by cold colors, darkness, asymmetry, and minimal movement reduce users' intentions. However, again, appropriate lighting can mitigate this effect, supporting the idea that well-lit environments foster positive user intentions and engagement (Presti et al., 2022). Configuration showed significant interactions between Balance and Level 2, suggesting that balanced compositions enhance the perception of spatial order and functionality, consistent with the principles of creating stable and harmonious designs (Wilson & Chatterjee, 2005).

Immersion was negatively impacted by Level 2, with significant interactions with Lighting suggesting that well-designed lighting can enhance immersion even in less stimulating environments. This aligns with literature emphasizing the role of lighting in creating immersive experiences (Cruz-Neira et al., 1993). Finally, Information Load was significantly reduced in Level 2 environments, indicating that these settings can create a calmer and less overwhelming space, but this effect is optimized with appropriate lighting (Presti et al., 2022).

5.3.1.9 Conclusions

This exploratory study aimed to assess the impact of four Visual Design Principles (VDPs)—Color, Lighting, Balance, and Movement—on Visitor Experience within eight distinct Virtual Reality Environments (VREs). The findings provide valuable insights into how these design features influence various affective and aesthetic dimensions of user experience.

Overall, Color, Lighting and Movement Design features emerged as significant factors affecting multiple dimensions, including Attraction, Pleasure, Stimulation, Perception, Intention, Configuration, Immersion, and Information Load. The results consistently indicated that environments characterized by cold colors, darkness, asymmetry, and minimal movement (Level 2) generally led to lower levels of attraction, pleasure, stimulation, and immersion compared to their counterparts. This is in line with previous research suggesting that warm colors, well-lit environments, and dynamic design elements are more positively perceived (Elliot & Maier, 2014; Ballast, 2013; Tang & Wang, 2019).

However, it is important to note that the numerous main effects observed at the level of lighting, regardless of the specific levels (bright vs. dark), underline the significant impact of this feature. Participants did not perceive substantial differences between the bright and dark environments, as evidenced by post hoc comparisons that consistently showed no significant differences between these lighting conditions across both affective and aesthetic dimensions. This could be attributed to the inherent difficulty of accurately rendering lighting characteristics in virtual reality environments and through head-mounted displays. Lighting is a complex element that might not be fully captured or appreciated in virtual settings, thus leading to similar evaluations of bright and dark conditions (Presti et al., 2022; Cruz-Neira et al., 1993).

Despite this, the preference for warm, symmetrical, and dynamic environments across various dimensions highlights the importance of these features in creating aesthetically pleasing and engaging virtual spaces (Wang & Hsu, 2020; Tang & Wang, 2019).

A major strength of this study was the ability to create VREs from an initial VRE of reference, keeping some characteristics constant while manipulating others. This controlled approach allowed for a precise examination of the effects of each design feature on UX/V. By maintaining a consistent base environment and systematically varying only specific elements, I could isolate and identify the impact of each design principle more accurately than would be possible in a more variable, real-world setting.

However, the study also has some limitations that need to be addressed.

That is, while the aforementioned experimental control adds value to the study by enabling precise testing of design features, it also introduces a limitation in terms of generalizability. Specifically, the findings are based on a single base Virtual Environment (VE) used as the reference point for manipulation. This raises questions about the extent to which these findings can be generalized to other types of virtual environments or real-world settings. For instance, the impact of the Visual Design Principles (VDPs) might differ in outdoor VEs, interactive gaming environments, or puzzle-based VEs. The immersive qualities, goals, and content of these

environments might moderate how VDPs influence user experience, leading to different affective and cognitive outcomes.

Additionally, while this study focused on a museum-like VE, the lack of diverse contextual scenarios limits the scope of conclusions. Future research should explore a wider range of virtual environments, including those designed for entertainment, education, or therapeutic purposes, to examine whether the observed preferences for warm, symmetrical, and dynamic designs remain consistent across contexts. This broader exploration would help clarify whether certain VDPs have universal effects or if their impact is context-dependent.

Finally, participants in this study were limited in their ability to navigate the virtual spaces. This restriction likely limited their ability to fully experience and evaluate the aesthetic qualities of the environments, akin to a museum experience. Future research should consider incorporating navigable virtual spaces to allow a more comprehensive assessment of UX. The ability to move freely within the virtual environment would provide a more immersive and realistic experience, potentially leading to more nuanced insights into how design features impact user perceptions and emotions.

In conclusion, this study highlights the significant influence of space design features on the aesthetic and affective dimensions of user experience in virtual environments. By strategically leveraging warm colors, balanced and dynamic elements, and effective lighting, designers can create virtual spaces that enhance attraction, pleasure, stimulation, perception, intention, configuration, immersion, and reduce information load. These insights may offer useful insights for creating engaging and satisfying virtual experiences, emphasizing the need for a holistic approach to environmental design. Furthermore, the findings underscore the value of controlled virtual environments for research while also pointing to the importance of further enhancing these environments to better simulate real-world experiences.

5.4 Key points of the chapter and conclusions

In conclusion, this chapter has explored the relationship between aesthetics, emotions, and the environment within the context of User Experience (UX) design. It has emphasized the critical role that space plays, not just as a passive backdrop but as an active participant in shaping the overall experience of users. Drawing from a diverse range of disciplines, including architecture, environmental psychology, and neuroscience, the chapter has offered a nuanced understanding of how different spatial elements—such as color, lighting, and balance—affect human perception, cognition, and emotion.

The chapter also examined how spaces are more than just physical structures; they carry emotional and symbolic significance, transforming from abstract "spaces" to meaningful "places" through human interaction and memory. This conceptual differentiation between space, place, and environment is vital for UX designers to create environments that not only meet functional needs but also resonate emotionally with users, enhancing their sense of well-being and engagement.

Furthermore, the chapter presented key studies, such as the impact of Visual Design Principles (VDPs) on emotional and aesthetic responses in virtual environments. These studies underline the importance of considering spatial aesthetics and design elements in UX research. By investigating user responses to variations in color, lighting, symmetry, and movement, the research demonstrated that well-designed environments can significantly enhance user engagement, emotional satisfaction, and overall experience. For instance, warm colors, dynamic movement, and balanced compositions were found to evoke more positive emotions and immersive experiences.

In terms of practical application, this chapter suggests that integrating aesthetic principles with environmental psychology can inform the design of both physical and virtual spaces. Whether for public spaces, work environments, or virtual platforms, understanding the psychological impact of space can lead to more effective and emotionally fulfilling designs. Though some limitations persist—such as the challenge of fully simulating real-world lighting in virtual settings—the findings point toward the growing utility of virtual environments as research tools for UX design.

Overall, this chapter highlights the significance of environmental design in shaping human experience, stressing that thoughtful manipulation of spatial elements can lead to more immersive, emotionally rich, and effective user experiences. This multidisciplinary approach, integrating technology, aesthetics, and psychology, offers valuable insights for advancing the field of UX design in both physical and digital domains.

6. General Discussion and Conclusions

6.1 Overview and context of the research

The term "User Experience" (UX) presents certain complexities, as, on one hand it anecdotally assumes a shared understanding of what it refers to. However, on the other hand, a systematic and scientific analysis of it reveals even more deeper complexities. Each day, we interact with a multitude of artifacts in various contexts—domestic, professional, social, and recreational. This assumes a dynamic interplay between the user, the artifact, and the context, which shapes the overall experience. With this thesis, I aimed to demonstrate the reasons why psychology positions itself as the key discipline for the study of UX. Subsequently, I conducted an analysis of the psychological processes that I consider to be the most important and least explored: the aesthetic and affective dimensions, as well as the behavioral outcomes resulting from our interactions with artifacts. I will now proceed to systematically analyze the different types of contributions obtained for each objective.

6.2 Contributions of the thesis

6.2.1 Theoretical Contributions

This thesis introduced the novel perspective of User Experience Psychology (UXP), positioning psychology as the foundational discipline for understanding UX. The rationale behind placing psychology at the core of UX analysis lies in the fact that both the concept of "experience" and the focus on the "user" are inherently psychological domains. Psychology has historically been concerned with the study of human behavior and experience since its inception, and in contemporary research, the investigation of human experiences represents a key frontier. Thus, psychology's long-standing expertise in exploring the intricacies of human cognition, emotions, and behavior makes it uniquely suited to delve into the complexities of UX, a domain that has traditionally been dominated by disciplines such as design, human-computer interaction (HCI) and cognitive science. However, these fields often emphasize technical aspects or usability, without fully engaging with the psychological dimensions that define and shape the user experience.

This leads to two highly relevant theoretical considerations. First, this broader understanding of the term "artifact" suggests that UX, given the growing complexity of interactions in modern life, must encompass a wide array of artifacts—both digital and physical—across diverse contexts. The thesis analyzes user experiences with architectural facades, paintings, a design bicycle, and a virtual museum, demonstrating that such diversity demands a comprehensive analysis that cannot be restricted to a specific type of artifact. Furthermore, and this is the first theoretical implication of the thesis, UX cannot be solely examined by disciplines that have

traditionally studied specific artifacts, such as design or architecture, as they may not fully capture the psychological aspects of user interactions.

The second innovative contribution of this thesis lies in its affirmation of UX as an inherently aesthetic experience. Unlike traditional approaches, which may view aesthetics as an add-on or secondary element in UX analysis, this work positions aesthetics at the forefront, integrating recent psychological evidence into the investigation. The thesis does not explore the aesthetic aspects of user interaction with artifacts; rather, it concludes that every interaction with any artifact, even those not overtly aesthetic, is inherently aesthetic in nature. This is because aesthetics, as understood in this analysis, involves affective, cognitive, and behavioral components that are present in all forms of interaction. Therefore, the analysis of user experience must consider these "aesthetic" dimensions, as they are integral to understanding how people perceive, engage with, and are influenced by the artifacts they encounter.

6.2.2 Methodological Contributions

The first key methodological innovation of this thesis aligns with the primary theoretical contribution outlined earlier: the application of psychology as the core discipline for the study of User Experience (UX). In this thesis, psychology was not treated as an auxiliary field but as a central framework for comprehensively analyzing UX. Drawing upon established psychological models of cognitive processes, emotional responses, and human behavior, this approach offers both predictive and explanatory power in understanding how users interact with artifacts and environments. Beyond theoretical models, this research employed a range of psychological methods, tailored to investigate these interactions in depth.

The use of Virtual Reality (VR) as both a methodological tool and an object of study represented another significant methodological innovation in this work. VR was not simply a medium for presenting stimuli but was central to the investigation for several reasons. First, its potential to create transformative experiences is unparalleled, as VR can simulate immersive environments that evoke strong emotional and cognitive responses. Second, VR is increasingly employed in UX research as a prototyping method, offering designers and researchers a flexible, controlled environment in which to test user interactions before physical products are created. Third, VR enables the creation of entirely new types of aesthetic experiences.

These aspects of VR were examined in all the empirical studies conducted as part of this research and whose contributions are briefly summarized in the paragraph below.

6.2.3 Empirical Contributions

The empirical findings of this thesis reinforce the critical role of affective and aesthetic dimensions in UX. Across different studies, from architectural facades to virtual museums, results consistently demonstrated that

emotional responses are central to how users interact with and evaluate artifacts. The findings support Norman's theory, which posits that visceral responses—the immediate, emotional reactions—are the first layer of engagement with any artifact. This was evident in the empirical studies involving both physical and virtual environments, where the emotional impact of design elements, such as symmetry and movement, played a pivotal role in shaping user behavior and perception.

In the study on the perception of architectural symmetry, the results highlighted the importance of affective responses in user interaction with artifacts, though the mediating role of emotions on prosocial behavior was not fully confirmed. The work further demonstrated that emotions significantly shape user experiences in VR environments, particularly in studies on a design bicycle and famous paintings. These findings underscore the need for UX design to account for the emotional and aesthetic engagement of users, rather than focusing solely on functionality or usability.

Finally, the research on virtual museums illustrated how space itself—both real and virtual—profoundly influences user experience. The spatial context not only affects the appreciation of artifacts but also enhances the overall aesthetic and emotional experience.

6.2.4 Practical Implications

The findings of this thesis present significant practical implications for both UX design and research, highlighting the critical importance of placing the user, along with their subjective experience, at the center of the design process. One of the most essential insights is that UX design should not merely address surface-level concerns such as technical functionality or aesthetic appeal, but must engage deeply with the user's cognitive, emotional, and behavioral responses to interactions with artifacts, environments, and technologies. This shift necessitates a more integrative, psychology-driven approach to UX, moving beyond traditional metrics of usability and interface design to encompass the full spectrum of human experience, including affective states, psychological needs, and decision-making processes.

Cognitive and emotional responses form the core of how users interpret and engage with designed artifacts. Cognitively, users process information through schemas and mental models that influence their navigation, problem-solving strategies, and decision-making. Emotional responses, on the other hand, are tied to user satisfaction, frustration, and motivation. UX designers must, therefore, prioritize an understanding of how design elements—such as color schemes, spatial arrangements, and interaction flows—affect both conscious and unconscious cognitive processes, as well as emotional states like pleasure, frustration, and engagement. Only by acknowledging this complexity can designers create user experiences that are not only efficient and functional but also emotionally resonant and cognitively engaging.

Furthermore, the incorporation of Virtual Reality (VR) as a research and prototyping tool, as demonstrated throughout this thesis, introduces transformative potential for UX practice. VR allows for the creation of highly immersive, multisensory environments where user behaviors, affective reactions, and cognitive load can be

studied in a controlled yet realistic manner. This enables designers to experiment with various design features—whether spatial configurations, interaction modalities, or visual aesthetics—in real-time, gathering immediate feedback on how users engage with and interpret the environment. Such immersive testing offers a level of depth and granularity not achievable in traditional design processes, providing insights into user preferences, stress points, and behavioral tendencies that can profoundly refine and optimize the final design.

The ability to simulate environments and predict user interactions within them is particularly valuable in complex UX projects, where physical prototypes may be costly or impractical. Through VR, designers can explore user responses to different design variations, identifying potential issues related to usability, emotional engagement, or cognitive overload early in the development process. This iterative approach ensures that the user experience is fine-tuned to meet user expectations before a design is finalized, thus reducing the risk of costly redesigns post-implementation.

Beyond its practical applications in design, VR also opens up new avenues for exploring the aesthetic dimensions of UX. Aesthetic experience is not limited to passive observation but is deeply intertwined with embodied interaction, emotional immersion, and cognitive engagement. In virtual environments, users are not merely observers but active participants, whose movements, perspectives, and emotions dynamically shape their experience. This adds a new layer of complexity to the design process, requiring UX professionals to consider not only how users perceive individual elements of a design but also how they emotionally and behaviorally respond to the immersive whole.

6.3 Limitations and Future Research Directions

Despite the contributions of this thesis, certain limitations should be acknowledged.

One primary theoretical limitation lies in the scope of the psychological frameworks applied. While this thesis positions psychology as a central discipline for understanding User Experience (UX), the analysis primarily focuses on cognitive, affective, and behavioral models. Other relevant psychological dimensions, such as social or cultural psychology, may not have been explored in sufficient depth. These factors could influence how different users from diverse cultural backgrounds or social contexts engage with artifacts, environments, and technologies. The absence of a more comprehensive cross-cultural examination might limit the generalizability of the findings, particularly in global UX applications.

From a methodological standpoint, the use of Virtual Reality (VR) as both a research tool and subject of study presents some constraints. Although VR provides a controlled and immersive environment for studying user interactions, it may not fully capture the complexities of real-world settings. Users' experiences in virtual environments, while insightful, might differ significantly from their interactions in physical spaces due to factors such as the limitations of VR hardware, motion sickness, or the artificiality of virtual stimuli. This could lead to a gap between findings derived from VR-based experiments and actual user behaviors in non-virtual environments.

Furthermore, the thesis focuses heavily on specific types of artifacts (e.g., architectural facades, paintings, a design bicycle), which, while diverse, do not encompass the full range of possible user interactions with everyday objects or digital technologies. The choice of these artifacts may limit the breadth of the findings and their applicability to other domains, such as UX in mobile applications, complex industrial designs, or smart technologies.

Finally, another potential methodological limitation relates to the reliance on self-report measures for assessing emotional and cognitive responses. While such measures are commonly used in psychological research, they can be subject to biases such as social desirability or inaccurate self-assessment. Complementing these subjective measures with objective physiological data (e.g., eye-tracking, heart rate, or neuroimaging) could provide a more comprehensive understanding of users' experiences.

In conclusion, as a final note from the author of this thesis, I would like to say that this thesis confronted me with complexity for multiple reasons: the necessity to integrate multiple disciplines, research lines, and research objects. UX is a complex discipline, inherently multidisciplinary, as is the study of our experience with artifacts. Here, I concentrated on the psychological approach, which itself is rooted in visual arts, design, and philosophy, among others. I tried, in a certain way, to redefine the concept of UX by declaring that it is primarily aesthetic, that any type of artifact can be considered, and that psychology, as a discipline that studies art and aesthetics, human behavior, and experience, is the ideal candidate for its comprehensive analysis.

What emerges clearly from the scientific literature is that studying our interaction with artifacts is essentially studying our interaction with the world and that aesthetics plays a fundamental role in this dynamic. It is not just about appreciation and beauty; its emotional drive compels us to approach or avoid artifacts, the spaces containing them, and others.

In these terms, the aesthetics of our experience with artifacts provides a window into our experience of the world: an experience that can be, depending on the characteristics of the artifact and its context, optimal, memorable, and potentially transformative.

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Appendix 2

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