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PERCEPTION, ACTION, AND EMOTIONS IN AESTHETIC EXPERIENCE: AN
INTERDISCIPLINARY APPROACH TO ENVIRONMENTAL SUSTAINABILITY

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Abstract

The present work describes an interdisciplinary project aimed at investigating how theories and empirical research methods of cognitive science can be applied to environmental sustainability. Consistently, the company chosen for partnership during my doctoral program *PON green* was Kilowatt (based in Bologna), whose work concerns green innovation, circular economy, and urban regeneration. In particular, my project addresses perception of objects' materials and their reuse in an artistic sense, focusing on how these processes can be modulated by the affective and cognitive aspects that characterize our interactions with the world, influencing our decisions and actions.

In pursuit of this objectives, the theoretical framework of this thesis encompasses three fundamental research areas: (a) Affordances, mainly from the perspective of Cognitive Psychology, by exploring crucial features such as the role of previous knowledge and action goals; (b) Beauty, mostly from the perspective of Empirical Aesthetics, by addressing the role of attraction, pleasure, motivations, and aesthetic emotions; (c) Sustainability, mainly from the perspective of Psychology of Climate Change, scrutinizing not only human decisions and behaviors, but addressing specifically the role that art can play for individual and social transformation. The conceptual background of all these topics is provided in Part I, whereas Part II and III describe the empirical studies that have been carried out.

The empirical investigation starts from objects' perception, focusing on how this process can be modulated by the aesthetic attractiveness entailed by a change in the sustainability of objects' materials. Thus, Study 1 attempts to connect research on affordances with knowledge on empirical aesthetics, intertwining our readiness for action with the effects of beauty on perception.

To delve into the fundamental mechanisms that come into play during aesthetic experience, Study 2 investigates aesthetic emotions and their variation in relation to individual motivations, analyzing the effects of experiencing a music concert across different modalities (live, in virtual reality, or in 2D) by participants who have different preferences and expectations.

Study 3 gets to the heart of the matter, trying to work out empirically whether the aesthetic experience of art made from reuse of waste material may influence pro-environmental intentions and behavior, considering the role affective and cognitive mechanisms, and how they relate to individual traits. This work was carried out at the University of Vienna, during my visiting period abroad.

Regarding the collaboration with Kilowatt company (6 months), I tried to apply the empirical methods of cognitive science outside the laboratory, rethinking ecological research that can be applied to local area activities with a focus on environmental issues. Within this partnership, Study 4 and 5 were conducted at the Greenhouses of Giardini Margherita, headquarters of Kilowatt. The former addresses the sustainability of space by investigating how communication through specific landmarks affects users' knowledge and behavior. Study 5, in turn, investigates the specific role that descriptive information can play in both our aesthetic experience and pro-environmental intentions, when applied to different types of art made from the reuse of waste material.

All in all, in my PhD project I tried to bridge domains that are typically far apart, and to apply cognitive science methods to aesthetics and ecology. Beyond the limitations of my research, the challenge as well as the originality of the present work lies in its interdisciplinarity, and in its applicative perspective on environmental sustainability.

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“And do you know, do you know that mankind can live without the Englishman, it can live without Germany, it can live only too well without the Russian man, it can live without science, without bread, and it only cannot live without beauty...”
(Fyodor Dostoyevsky, *Demons*, 1872).

INTRODUCTION

Life is action. Through actions we achieve our goals, as well as our desires. Our actions come from our decisions, which in turn, are influenced by our needs, thoughts, and feelings. These are all continuously stimulated by the world around us, by what we experience. In short, everything starts with our life and what we perceive in the world.

One of the most urgent problems that the world is facing right now regards the preservation of its ecosystem, and our own existence within it. The ultimate purpose of my three-year PhD project was to gain new insights into how we can encourage people to adopt more environmentally sustainable intentions and behaviors. This was of course not an easy goal, since it encompasses several areas of knowledge, from philosophy to economics, from psychology to social science. The approach of this thesis is that of cognitive science, but at the same time, an approach to such a topic can only be an interdisciplinary and transdisciplinary approach as well. Specifically, I wanted to address the issue by investigating our perception in terms of cognitive and affective mechanisms related to our decisions. Yet, this was a lens still too wide to approach the topic. I rather needed to choose one element on which my investigation could focus. Thus, I initially decided to focus on beauty. The philosophical and scientific reason for which I made this choice will be largely discussed throughout all the present work. The naive reason from which I initially thought of making this choice probably comes, indeed, from my experience of life. We human beings do not have the physiological necessity to perceive beauty in our life in order to survive, as we instead need food or water, yet it seems that beauty is what we all look for. The fact that we all seem to pursue this thing, even if we do not necessarily need it to live, is perhaps what makes its investigation even more fascinating. Indeed, life is not just about what we need, but also about what we like, what we dream of, basically, about what we love. Beauty moves us emotionally, and yet not just in a figurative way. Sometimes, it even seems as if beauty is what makes a life worth to be lived.

The idea that I wanted to develop across my project was to prove that beauty can influence our decisions and actions, and thus being an incredible powerful tool for sustainability, a way to make people do the right thing. Though, this was not as simple as it is said. As soon as I started to develop this idea, I faced what such a mission really meant, that is, the enormous and intricate question of what it is that drives our preferences. Suddenly then, I had to take a step back. My research could not start from the question “Can beauty save the

world?”, but it needed to start from “Why do we like what we like?”. Evidently, there are several factors hidden behind this question, aspects of life that contribute to creating our preferences. The more I was investigating, the deeper the research needed to go, and it seemed as if the answer could be never caught. I started to feel like Achilles with the Tortoise in Zeno’s paradox: even if I was getting closer, I was never able to actually reach it. My basic assumption was that people will always opt for what they like instead of what they don’t like, and beauty may often be very easy to recognize. Yet, it feels impossible to grasp its essence. Notwithstanding, during this long journey, while I was trying to reach my Tortoise, I happened to cross many other important things that needed my consideration: experience, knowledge, attention, language, goals, emotions, expectations, motivations. All these things seemed to be part of the picture, and they had to be somehow taken into account.

Our lives are shaped, molded, and conditioned by the environment we live in. Hence, to understand how people could make the right decision, I needed to start my investigation from how we perceive the world around us. As human beings, we do not only act to live, but we also have the ability to interpret and reflect on our own actions, which are connected to our plans and goals, and subject to our needs, emotions and desires (Taylor & Noë, 2021). Thus, if we want to fully understand the whole spectrum of the processes that start from perception and ends in our actions, we should consider how our perception of things and interaction with the world happens and captures our attentions toward specific elements, and then, how cognitive and affective mechanisms that involve our reflective and emotional states bring to our decisions and behaviors. The present work aims to investigate both kinds of processes which are, inevitably, related to each other. To accomplish this purpose, my research focused specifically on two phenomena: affordances and aesthetic experience. Undoubtedly, both regards how humans perceive and interact with the world, and both can be considered as the result of cognitive, affective, and motor processes which intervene in our perception, emotions, preferences, decisions, and actions.

Affordances research shows how we *can* perceive lots of action possibilities, but then we often opt for what is more salient to us. Literature of aesthetic experience, in turn, points out that when we perceive something we construct meaning about what we are seeing, while we also receive an affective impact from it. In both cases, then, there is a perception-interpretation process that works through our prior experience and knowledge, that is subjectively felt in terms of motivation, expectation, and attraction, and that brings to cognitive reflections and evaluations which, in turn, will influence our choices and actions in relation to our goals, to what finally satisfies us. Anyway, before all this even happens, before reflections,

evaluations and decisions, there is always the first impact, the first look, the first perceptive impression. Everything starts there. There is something at the beginning of our perception that strikes our attention, and sometimes beauty is exactly that thing.

By linking these two areas of investigation, I aimed to gain insights into how our preferences and the pleasure that comes from the perception of beauty, shaped by both cognitive affordances and aesthetic experience, can motivate and induce pro-environmental choices and behavior. In both phenomena, there is ultimately a judgement that brings to a choice for action, whether it concerns using an object or not, or keeping looking at an artwork or not. In the present thesis, I try to unpack these mechanisms in order to understand how they can apply to sustainability, hence, how they can lead to choices and actions in favor of the environment. Specifically, the work is divided in three parts: Part I (from Chapter I to IV) represents the theoretical framework of my research, Part II (from Chapter V to VII) regards the first three empirical studies that have been carried out, and Part III (Chapters VIII and IX) concerns the two further experiments that I have conducted within the period of collaboration with Kilowatt, the partner company of my project.

In **Chapter I**, it will be argued why affordance needs to be understood as properties emerging from subject-object-environment interactions, characterized simultaneously by several dynamic conditions: the conditions of the environment (the context), the properties of the object, and the characteristics of the individual (physical potentialities, cognitive capacities, affective and motivational states, past knowledge and previous experience). These conditions may depend on either the *inside* (body and mind) or the *outside* (objects and environment), and the activation of affordances for potential actions depends on the outcome of these interactions. A general overview on the concept of affordance will be traced, from its reformulation by the embodied cognition research, to the new hints suggested by the predictive processing accounts; some of its key features will be discussed, such as the role of our prior experience and knowledge, action goals, and finally the importance of the aesthetic attraction.

The investigation on the role of aesthetic attractiveness is what leads to **Chapter II**. Here, a general introduction to the field of Empirical Aesthetics will be given. With this term is to be considered “the scientific field that uses empirical methods to study aesthetics” (Nadal & Vartarian, 2022, p.3). This definition thus assumes that Empirical Aesthetics concerns the scientific knowledge about aesthetics investigated with empirical methods. What exactly *aesthetics* is and what makes an aesthetic experience unique is still an ongoing (and probably everlasting) debate. Many crucial aspects will be considered, from its philosophical roots and

the existence of a “sense of beauty”, to the role that individual meanings and expectations can play in forming our preferences and aesthetic judgments. As for affordances, new perspectives will be suggested according to predictive processing accounts, specifically in relation to the uncertainty of novelty and the pleasure that derives from understanding the unexpected. What will not be considered is to have a final definition of aesthetic experience.

However, a clear conceptual definition is not necessary to draw parallelism with affordances, which is the scope of **Chapter III**. Evidently, in terms of perceptual process, aesthetic experience should be considered as a complex interaction between factors related to the object, the individual, and the context (Jacobsen, 2006). Hence, regardless of the different definitions, this juxtaposition in this thesis starts from the basis that: a) the experience with the aesthetic object is also a sensory-perceptual experience; b) the aesthetic object is contemplated, because its aesthetic appearance is the object of interpretation and evaluation by the subject, who attributes meaning and value to it (Scruton & Murno, 2023). The dialogue between these two pieces of literature is thus legitimized by the fact that, in both cases, it concerns a perceptual process that regards an interaction subject-object-context, and it involves meaningful-experiential processes, as well as affective-evaluative and motor-perception factors (Shusterman, 1997; Chatterjee & Vartarian, 2014; Rietveld & Kiverstein, 2014). Beyond the mere theoretical bases, also some similarities between the neural processes involved in both phenomena will be discussed. The core of the parallelism, then, will be developed on two crucial aspects: the importance of aesthetic attractiveness for affordances, and the role of action in the aesthetic experience with art. This latter, in turn, opens the way to further arguments. Indeed, the involvement of our actions in the perception of art brings up two of the most debated topics in Empirical Aesthetic, that are, whether aesthetic pleasure is disinterested (i.e., not related to any functionality), and if it can be actually traced a real difference between regular emotions and aesthetic emotions. As will be discussed, these complex arguments cannot be completely addressed, but it should be still possible to identify some crucial elements, among which there are certainly our expectations and motivations.

Given these intermediate steps, the last theoretical chapter, **Chapter IV**, concerns the premises for the final purpose of my investigation, namely, to find out how art can actually encourage pro-environmental behavior. Environmental sustainability is a global problem, and it has been proved that individual behavior may have a crucial role in it. Hence, researchers from many different fields keep studying ways to enhance awareness and encourage pro-environmental actions. My project aimed at addressing sustainability interweaving cognitive

science research and art. Indeed, art is commonly believed to have a unique power to boost people's affective and cognitive engagement, touching values, knowledge, and beliefs, in ways that might strike deeper than the often too dry scientific data. Specifically, Environmental art is notably dedicated to this objective. Though, the psychology of climate change is characterized by some peculiarities that need specific examinations and tailor-made solutions to be contrasted. All these aspects will be discussed, including how these issues have been approached from different areas of research, as well as the role of emotions and attitude in shaping environmental behavior, the specific features of this latter, and the question on what role beauty can play in all this. Finally, a general overview about environmental art will be given, including some crucial aspects, possible models, and limitations.

Chapter V concerns the first empirical experiment of Part II (Study 1 – “Aesthetic experience and Affordance”, conducted in collaboration with the Department of Dynamic and Clinical Psychology, and Health Studies of La Sapienza University of Rome) which is related to the first core aspect of the parallelism discussed in Chapter III, i.e., the importance of aesthetic attractiveness for affordances. Indeed, to study this aspect in relation to sustainability, we decided to investigate our readiness for action toward everyday objects and their modulation according to the change of material. The perception of objects is something that involves and affects continuously our daily lives, thus, a crucial investigation in terms of preferences and sustainability concerns indeed how we differently perceive and elaborate affordances between everyday objects made of sustainable and non-sustainable material (namely, wood and plastic), and how they modulate our responses when embedded in physical and linguistical contexts. In addition, we believe that their aesthetic attraction can play a significant difference, and thus we questioned the role of beauty.

Chapter VI regards our second empirical experiment (Study 2 – “Aesthetic experience and Emotions”, conducted in collaboration with the Department of the Arts of the University of Bologna) in which we investigated the modulation of our aesthetic emotions in respect to the two crucial aspects of aesthetic experience previously mentioned: motivations and expectations. We did it with the adoption of new technologies through which it has been possible to compare the emotional response to a musical concert experienced through different modalities (live in theatre, in virtual reality, or on a computer) and by different groups of people (i.e., different participants' sample), thus entailing distinctive approaches and preferences.

Chapter VII reports the last empirical study of Part II (Study 3 – “Aesthetic experience and Environmental Art”), conducted at the Department of Cognition, Emotion, and Methods in Psychology of the University of Vienna during my visiting period abroad. In line with the theoretical premises discussed in Chapter IV, this study aimed to test the effect of visual images representing artistic creations made from plastic waste and with the purpose of highlighting the importance and urgency of this environmental issue. Specifically, we measured environmental intentions and willingness to donate in favor of the environment, comparing responses across different groups that experienced either the above-mentioned type of environmental artworks, pictures of clean nature, or just general contemporary artworks not related to environmental issues. Further, we checked also for cognitive and affective mechanisms involved in the different types of experiences, as well as the correlation between intentions, emotions, beauty, meaningfulness, cognitive reflection, and the participants’ individual traits in respect to environment protection such as attitude, beliefs, values, ecological worldview, and further factors. Hence, in this study we tried to put together most of the elements that I encounter in my research journey. Beauty is indeed one of them, but it is far from being alone.

Finally, Part III of the present thesis concerns the research that I conducted in collaboration with the company partner of my project, the social cooperative Kilowatt which is based in the Greenhouses of Giardini Margherita in Bologna. Indeed, my PhD scholarship is part of the National Operational Program (PON) Research and Innovation 2014-2020, specifically for the category of “Doctorates on Green Themes” (Action IV.5 of the Program). This specific scholarship envisaged six months of collaboration with a company which carries out activities within the environmental sustainability area and in relation to the same local territory of the University of reference (i.e., Bologna). The aim of this program is to encourage the academic institutions’ Third Mission and apply their research within the local community. Kilowatt is a cooperative that works in social innovation, circular economy, communication, and urban sustainable renovation. Therefore, our encounter was a chance to produce a fruitful collaboration for both parties: on one side, the company could dispose of our empirical scientific knowledge and methodologies to examine its activities and investigate the efficiency of its work in relation to sustainability. On the other hand, for us it constituted a precious opportunity to bring our research outside the laboratory, implementing empirical experiments within a green place that is intimately related to an overall sustainable mindset. Our partnership thus led to the implementation of two further studies.

Chapter VIII regards Study 4 (“Aesthetic experience and Space” – conducted in collaboration with the Department of Psychology of the University of Bologna) in which we applied empirical methods to study the sustainability of the Greenhouses space, specifically investigating people’s orientation within the place in relation to its landmarks and the sustainable conduct that they convey. This was supposed to be done in two distinctive phases, comparing two different sets of communicative signage-landmarks. Due to a delay in the company’s work, it was not possible to accomplish the second phase. Hence, this study reports only the data and results collected in the first phase.

Chapter IX regards a pilot study that has been implemented in the second part of the collaboration with Kilowatt (Study 5 – “Aesthetic experience and Descriptive Information in the Art of Re-purposing”). Given the results obtained in Study 3 (“Aesthetic experience and Environmental Art”), in this last experiment we tested the role that the addition of descriptive information can play in the experience with different type of art made from waste materials. Precisely, we compared some of the same environmental artworks used in the previous study with other type of artistical creations made with reused scrap materials, so to check for any difference in the cognitive and affective mechanisms related to the respective experience, as well as differences in intentions in favor of the environment and their correlation with participant’s individual traits.

All in all, the present thesis reports the studies and the investigations that constitute my overall doctoral work, describing the theoretical research and the empirical attempts that followed the general aim of the project, namely, how the literature and the methods of cognitive sciences can cross with art and sustainability, for the search and development of new strategies to confront with such an urgent issue as the environmental crisis.

PART I

**AFFORDANCES, AESTHETIC EXPERIENCE,
AND SUSTAINABILITY**

CHAPTER I

AFFORDANCES

1.1. An introduction to affordances: from Gibson's direct perception to the embodied cognition account.

In the last three decades the embodied cognition view (i.e., that cognition is grounded in perception and action through a body interacting with its environment) has renewed the notion of affordance since Gibson's first conceptualization (Kiverstein & Miller, 2015; Kiverstein & Artese, 2024). When Gibson (1979) introduced this concept as “affordances of the environment are what it *offers* the animal” (p. 127), he intended to highlight the fact that we perceive the world also in terms of action possibilities and not just in relation to its physical properties. For the embodied account of cognition, objects are represented as patterns of potential actions, rather than in terms of their solely perceptual characteristics (Barsalou, 2008; Chemero, 2013), and this view brought to a renewal of Gibson's affordances (Kiverstein, 2012; Rietveld & Kiverstein, 2014). Hence, in the last three decades, the extensive investigation on our sensorimotor understanding of the world has given evidence that expanded and revised the original concept in a broader framework.

In Gibson's view, we perceive the physical properties of an object according to internal motivation and action possibilities, but these characteristics are recorded directly by our perception with no need of prior knowledge about the nature of the object (Gibson, 1977; 1979). Gibson stressed the fact that the physical properties of the environment must not be understood in their objective meaning: the characteristic of his theory of direct perception is exactly that our sensory systems does not need higher-level cognitive processes mediation to elaborate the information (Gibson, 1966). Conversely, Tucker and Ellis (1998; 2000; 2001), although they agreed that affordances are activated automatically, showed through their experiments that it is necessary to activate knowledge related to the object in order to guide actions. They then ascribed crucial relevance to the brain, namely, to our neural representation of the object. Hence, the first crucial shift that experimental psychology took from the ecological perspective of Gibsonian direct perception is the integration of the computational

component of mental representations into the concept of affordance. Further, in addition to the representation, Ellis & Tucker (2000) concept of micro-affordances assert that the association between vision and action give rise to action potentiation whenever an object is seen and “*whatever the intentions of the viewer*” (p.468). Though, subsequently, Bub, Masson, and Cree (2008; 2010) found that different purposes of use evoked different grasping gestures, thus extending the micro-affordance perspective. Their findings showed that affordances are indeed automatically evoked by objects, but this happens through memory representations and intentions to act on or with them. Similarly, Jax and Buxbaum (2010) classified affordances based on the structural properties (e.g., shape, size, orientation) and on the functional information (i.e., on the use) of an object, associating it with two types of grasping actions. They found that in general, grasp responses were faster than those related to use, though specifically, reaction times were slower during the use responses toward conflict objects (i.e., objects with competing structure and function responses, so associable with different types of actions), independently of the task order. The general interpretation was that functional responses involve the activation of long-term conceptual representations, while grasp responses do not, thus confirming that the activation of affordances is automatic, but also emphasizing the necessity to activate our object representations to guide the actions.

In sum, whether for Gibson's ecological approach our perception is not influenced by inferential processes and does not require mental structures or representations (Hochberg, 1994), thus connoting affordances as natural relationships that do not require pre-existing knowledge or any necessary need to be perceived (Chong & Proctor, 2020), the experimental research from Tucker and Ellis onwards, instead, in line with an embodied approach to cognition demonstrated that our knowledge-experience and our intentions in relation to the object that we perceive are decisively involved in the interaction. The inclusion of these two elements represents the core distinction with the original concept of affordances, and this has brought to a proliferation of proposals and revisions in literature. Norman (1999; 2002), for instance, in order to make explicit the different nuance, rebranded the Gibsonian concept as *physical affordance*, to which he contrasted a new reformulation of *perceived affordances*. Similarly, Bub and Masson (2010) preferred to use the notion of *motor affordance* to refer to reach-and-grasp responses (Bub et al., 2018), and that of *action representation* for the motor response linked to the image of an object (and thus not to a true 3D graspable object: Masson, 2018).

In any case, regardless of the conceptual theoretical debate, this shift represented the starting point for a multitude of research. Depending on objects' physical properties, on the condition of our body and mind, and on our goals, the studies that followed found each time different types of affordances that may be perceived: stable, canonical or variable affordances (Borghi & Riggio 2009; 2015), volumetric/structural and functional ones (Bub et al., 2008), multiple (Pezzulo et al., 2010), broken (Buccino et al., 2009), dangerous (Anelli et al., 2012; 2013a; 2013b), and social ones (Borghi et al., 2011; Gianelli et al., 2011; 2013a; 2013b; Ferri et al., 2010; 2011). Further, the framing of the interaction between object and perceiver is clearly due to the context, which intervenes transversally in the perceptual process, inhibiting or facilitating the activation of affordances. For instance, the mere distance from objects can influence the activation of affordances (Costantini et al., 2011a), as well as the presence of other people (Costantini et al., 2011b; Scorolli et al., 2014), and this may happen by accentuating a competition and thus forcing an anticipation (Gianelli et al., 2013a), or increasing the salience of the object (Candidi et al., 2017). Moreover, social norms can alter attitude and thus the outcome of interaction (Scorolli et al., 2017; Constable et al., 2016; Constable et al., 2014), and language can act as a sort of filter, encoding only some kinds of affordances (Borghi & Riggio, 2015; Garofalo et al., 2021; 2024). Finally, in addition to the physical and social dimension and the cultural practices of the context (Rietveld & Kiverstein, 2014), also the affective dimension can play a determining role (e.g. Caravà & Scorolli, 2020; Kiverstein & Miller, 2015).

All in all, the conjunction of visual and motor experiences in the brain, and the perspective on cognition as the outcome of our simulating previous experiences, knowledge, and goals, has increased scientific interest in the neural networks involved in visual processing, opening up an immense range of possible investigations. Since our interaction with objects (the external world) and the resulting affordances are influenced by the synergy of multiple factors related to the physical properties of the object, the characteristics of the subject (physical, experiential, motivational, cognitive, and affective), and the context in which the interaction occurs, thus, the investigation on our perception should shift the focus from *what* we perceive to *how* we perceive it. Since there is no clear separation between the perceptual, cognitive and motor systems, the crucial point is not so much the nature of affordances, but rather how they are perceived: “the crucial question is not if the affordances pre-exist or not, if they are perceptible or hidden, but how are they ‘perceived’ or detected as action possibilities” (Xenakis & Arnellos, 2013, p.7). As said, previous knowledge-experience and our intentions-goals are

two crucial elements for our perception and interaction with the external world. Thus, the first objective of this chapter is to explore more deeply these two elements, and then propose the addition of a third one as equivalently fundamental: our preferences shaped by the aesthetic attractiveness of things.

1.2. Past experience and previous knowledge

The fact that our past experience can have an influence on our interaction with the world is demonstrable first and foremost from a neurophysiological point of view: the cortex of our brain is plastic, since it has the ability to change structure and function, and it is experience that is one of the most powerful stimulators of this plasticity (Hebb, 1949). Experience-induced changes in the neural architecture are due to brain plasticity (i.e., the capability of the system to organize and re-organize) and the role of experience in shaping cortical circuits has been extensively documented in the developing brain and in the adult brain (Lövdén, Wenger, Mårtensson, Lindenberger, & Bäckman, 2013; Maguire et al., 2003; Scott & Monesson, 2010). Indeed, it is now well established in behavioral neuroscience that experience can modify brain structure long after brain development is complete, and these changes include dendrite length, glial activity, and synapse formation (Kolb & Whishaw, 1998). In the associative areas of the cerebral cortex there can be great individual variation, which results in differences in the processes to which these areas are linked, such as storing information, directing attention, and planning actions (Purves, 2021; Anderson & Mozer, 2014). In the infero-temporal cortex, for example, there are columns of neurons dedicated to the recognition of certain types of objects, in which each neural layer is specific to a particular category of shape, and the composition of these columns derives from our experience (Mountcastle, 1997)¹. In fact, we recognize shapes implicitly in our experience, we literally ‘see’ based on our experience (Dewey, 1958/1929). The difference between simply recognizing the shape of objects and moving them (thus, using them) could be translated into the difference between manipulation and function activated by affordances (Jax & Buxbaum 2010; Kalénine et al. 2014), with the latter being inevitably linked

¹ Our optical vision occurs through two distinct types of cells: parvo-cellular cells specialize in perceiving the shape of objects (edges, light, darkness) while magno-cellular cells perceive movement (how things change). The activity of these cells begins separately in the retina, continuing through the thalamus and into the primary visual cortex, from which the information is then sent to the other areas of the brain, again separately: specifically, shape recognition passes ventrally through the temporal lobe, while movement passes dorsally (for more details about this see Purves, 2021).

to the experience we already had with objects. When we see an object for the first time, in fact, only manipulative affordances are activated, but once we learn how to use it, functional affordances are then activated to the point of prevailing more frequently over the former (Borghi, 2018), demonstrating also the weight that action goal can have in guiding our perception of objects.

1.3. Action goals

In relation to the link between our cognitive abilities (such as perception) and goal-directed motor activity, there are several theories. For example, according to the theory of event coding (TEC) (Hommel et al. 2001), the perceptual process begins with the observer's goal rather than with the stimulus itself: once activated, the action goals lead to the consequent activation of the codes related to the visual components of the action (Hommel, 2019). Furthermore, the Motor Cognition Hypothesis (Gallese et al., 2009), in line with various studies that show how the brain's motor areas respond to visual, auditory and somato-sensory perceptual inputs (Rizzolatti & Gallese, 1997; Fogassi et al, 1996; Rizzolatti et al., 2000), claims that various cognitive abilities (including precisely the perception of objects that occupy our visual field) are possible thanks to the peculiar functional architecture of our motor system, which is organized in terms of goal-directed motor acts (Gallese, 2018). Evidence from several significant studies on affordances carried out in the last twenty years amply show how this goal-oriented actions lean mostly toward what we understand as useful and meaningful (for a review see: Borghi, 2018). In particular, the two key elements that determine this activation are mostly the task (Tipper et al. 2006; Borghi et al. 2007; Pellicano et al. 2010) and the context (Borghi et al 2012; Yoon et al. 2010; Kalénine et al. 2014; Buccino et al 2009; for a review see Borghi & Riggio 2015; van Elk et al. 2014).

The importance of goals in our actions brings up to focus the role of our intentions. Indeed, we do not only see all possible types of actions when we perceive an object, we also select between those options and decide which one to take. This view is supported by the Affordance Competition Hypothesis (Cisek, 2007), which claims that the process of action selection and specification occurs simultaneously with perception, and it continues during the execution of movements. Cisek's model suggests that decisions about actions to be performed are made through the same neural circuits that control the motor execution of those same actions, and these circuits are distributed over a wide area of brain regions. Specifically, in the

fronto-parietal system there would be a competition between potential actions, in which cells entailing different options for movement inhibit each other, whereas those with similar preference parameters elicit each other (a mechanism related to the biased competition of visual attention theories: Desimone, 1998; Boynton, 2005). The ‘winning’ of the final action is conditioned by many variables that give it force, among which the most significant are: salience, expected reward, and probability estimates, given that the competition in the fronto-parietal system is influenced by various other brain regions such as the basal ganglia (Redgrave et al., 1999) and the pre-frontal cortex (Miller, 2000; Tanji & Hoshi, 2001).

Several variables therefore intervene in our perceptual processes, the neural substrates of which are interconnected in the relationship between stimulus perception and movement execution. The selection of an action and its implementation (i.e., specification) are not separate processes, rather, they are connected and bi-directional neural processes, and this means that the very recognition of an object can be linked and activated by decision-making mechanisms linked to specific actions attributed to that object (and to the context in which the interaction takes place). These action objectives, in turn, are intrinsically linked to our prior knowledge which contributes to making the object (or certain parts of it) more or less salient.

1.4. Predictive processing and 4E cognition

Lastly, given that the activation of affordances is a process closely connected to our prior knowledge and action goals, the reconceiving of its concept comes inevitably under the light of two accounts that have gained momentum in the philosophical and neurocognitive debate: predictive processing² and 4E cognition. For Predictive processing theories (Clark 2015; Hohwy, 2020), the brain functions as a predictive machine that predicts the incoming sensory signal present in the world, constructing it in advance by itself through its prior knowledge (Pezzulo and Cisek, 2016), thus using a top-down predictive mechanism in which perception functions as a process that is continuous with action (Clark, 2015). This is a reversal of the classical view in cognitive science (which is also often the commonsense view), namely, that perception is all about a passive incision that the world operates on the senses and the brain

² Note for the reader: in the present thesis some of the features attributed to predictive processing might be more precisely referring to active inference. Although I’m aware of the difference, for the scope of the present work it was not deemed necessary to specify this distinction in detail. Hence, I will use only the expression “predictive processing”. For more details, please check all the references included in order to resolve any ambiguities.

(Von Helmholtz, 2013), and its processes function as in a purely bottom-up analysis, that is, from the external world to our brain through the mediation of our senses (Egner et al. 2010). Predictive processing, instead, includes a top-down predictive aspect. In this view, perception functions as a process that is continuous with action: the stimuli arrive at the senses, but they are also influenced by our top-down expectations about them. One clear example of this is the hollow face illusion (Gregory, 1970), namely a strong visual bias for which we see a hollow mask as a normal convex face. Top-down knowledge of faces is so strong that the bottom-up information clashes against it, so that we see a convex face even if we know about the illusion. This effect is evidence for the power of top-down perceptual knowledge for vision, which is distinctive from conceptual knowledge, because it is unconscious (Gregory, 1997). For predictive processing, perceiving the world around us is an epistemic activity in which, when the top-down expectations are not good predictors of the incoming stimulation (i.e., they are not precise enough to be interpreted), the agent (individual) explores the world in every conceivable direction, asking questions and producing data as he searches what he needs to act for (Clark, 2015).

This view is interweaved with the 4E account of human cognition (embodied, embedded, enactive, extended) that has developed in the last decades. Enactive accounts, for instance, pointed out that cognition is a dynamical process that exists in the fluid and continuous relation between a subject and its environment (Varela et al., 1991; Harvey et al., 2016; Heras-Escribano, 2019; Hutto & Myin, 2017), making vision as an ongoing and attentive interaction of an embodied observer (Noë & O'Regan, 2002; Kiverstein, 2012). According to this view, perception is always an inferential process, so that we always actively infer a model of the world by top-down influences, with the aim to act within the environment (Pierce, 1980). According to this view, even if unconscious, interpretation has a sort of primacy over perception. For instance, an empirical proof of how interpretation comes before perception could be found in Kaniza's triangle (1980), since we perceive the triangle even though the stimulus is not actually given to us (Paolucci, 2021). Indeed, Gestalt theories showed how the sensory signal is structured by immanent laws that shape our experience, constructing saliences and meanings that modulate our perception (Hochberg, 1998). Predictive processing claims that we use these saliences and meanings as *priors* when we perceive something, i.e., as interpretative schemata derived from our prior experiences and previous knowledge-information, and so we anticipate the perceptual signal through inferences based on these priors (Hohwy, 2017). The matching between the mind's inferences and what we perceive of the

external environment would result in how we construct the world, as if we anticipate perception by our priors and then the environment confirms the accuracy of our predictions or not. When the top-down signal is coupled with the perceptual signal, then prediction is accurate, but if it is not so, our system updates: "It is the deviations from what is predicted that then carry the 'news', quantified as the difference (the 'prediction error') between the actual current signal and the predicted one." (Clark, 2015, p. 26). In sum, perception is not simply the passive reception of inputs, but we actively infer the causes of our sensations (Friston, 2005), and these inferences are influenced by our prior experiences (Rao & Ballard, 1999; Ronga et al., 2017). Then, when the prediction is wrong, the error (i.e., the mismatch between priors and inputs) will contribute to belief updating (Adams et al., 2013).

1.5. Toward Study 1 - "Aesthetic experience and Affordance"

Therefore, as shown, our previous knowledge-experience and our intentions-goals are two crucial elements for the activation of affordances, and thus, for our perception of the objects and the world-environment around us. As anticipated, in addition to these two elements, in the theoretical framework of the present thesis (as well as for the empirical works reported) a third aspect is suggested to play a crucial role for our visual perception processes, namely, our preferences in relation to the aesthetic attractiveness of what we see. The regulatory role of aesthetic appreciation in human interaction with the environment is still debated (Xenakis & Arnellos, 2015; 2014). Though, evidence show that aesthetic feelings may have a functional significance in driving our day-to-day activities (Rolls, 2015; Xenakis, Arnellos, & Darzentas, 2012), hence, it is crucial to clarify how and when the aesthetic experience interfaces with the sequence of emotional and cognitive processes underlying the stimulus elaboration. Indeed, despite the now very large research on affordance, there are not so many studies that documented how the different perceptual aspects of a single object are integrated so as to maximize the possibilities of interaction with it. Specifically, most empirical work in cognitive science has focused on the shape and size of objects, eventually disregarding the analysis of other visual properties. For instance, only a few studies have highlighted that there is a close link between color and shape (e.g., Garofalo and Riggio, 2022), or that the object's consistency can play a significant role (Anelli et al., 2010). In Study 1 – "Aesthetic experience and Affordance" (Chapter V) we investigated the affordance activation by everyday objects modulated by the change of material, a component not so much examined within this type of literature (see Strappini et al., 2023, for a review). Specifically, we explored the modulation in

relation to the sustainability of the material (i.e., the environmental impact of the material: Florez et al., 2013) comparing the same type of everyday object made of sustainable (namely, wood) or non-sustainable (plastic) material. This change, in turn, may entail a fundamental shift in the aesthetic pleasantness (i.e., beauty: Augustin et al., 2012; Jacobsen, 2006; Reber et al., 2004) of the object. Thus, we consider the processes that this aesthetic change could bring to the surface as having crucial importance for a broader understanding of this interaction. This brings us to the connection with Empirical Aesthetic research on the aesthetic attractiveness of beauty and its connection with our emotions and evaluations.

CHAPTER II

AESTHETIC EXPERIENCE

2.1. The roots of Aesthetics

What is aesthetics? In classical Greek the verb *aisthanomai* means “to perceive”, and the noun *aisthēsis* stands for “sensory perception” (Berlyne, 1974). The first one to use this word in relation to philosophical knowledge was Baumgarten (1750) when proposing to investigate the acquisition of knowledge through perception and imagination, rather than just with reason or logic. From him onwards, philosophical writings (which are historically the most influential in the study of the aesthetics) have formulated several (and often contradictory) meanings concerning the processes that are related to perception and evaluation of an aesthetic experience (Nadal & Ureña, 2022; Xenakis & Arnellos, 2015). Indeed, in the same historical period when the first definitions of aesthetics were made, philosophers started also to try defining what differentiate art to non-art, which often brought to overlap the two concepts and led to misconception or confusing definition even in contemporary writings (Danto, 1996). Conversely, “the connection between art and aesthetics is a matter of historical contingency, and not part of the essence of art” (Danto, 1997, p.25). Remarkably, Daniel Berlyne, whose scientific research on art gave a new start which brought up to what is now the contemporary field of Empirical Aesthetics (Nadal & Vartarian, 2022), argued that it is not possible to clearly define the boundaries of aesthetics:

Aesthetics it's certainly concerned with arts, but it is not limited to the arts. There is an aesthetic aspect to many other activities, from mathematics to housework. In fact, one can argue that everything in life has its aesthetic side. (Berlyne, 1974: 1)

This assumption falls in line with Dewey's pragmatist view, for which we cannot be able to say what is aesthetic unless we define what is not aesthetic (Dewey, 1980/1934), thus claiming the broader conceptualization for which any meaningful experience is an aesthetic experience (Dewey, 1958/1929).

Today, for contemporary Empirical Aesthetics, an aesthetic experience is utterly not exclusively related to art (Pearce et al., 2016; Menninghaus et al., 2019; Xenakis & Arnellos, 2015). Rather, regardless of the definition about what is or what is not, a firm point is that it surely concerns our preferences, and the pleasure related to them. Indeed, aesthetics as an experimental psychology begins with Fechner (1876) and his research on what people like and dislike, which comes from the need to empirically investigate and understand what brings pleasure. His experiments and observations brought him to the conclusion that liking and disliking are related to two complementary factors: the structural object features and their arrangements (e.g., organization, complexity, proportion), as well as the knowledge, memories, and past experiences each person brought to the encounter with the object (Nadal & Ureña, 2022). Nevertheless, the debate on the roots of our preferences (i.e., about what is that we find beautiful and pleasurable) has barely ever stopped since ancient times until now (Reber et al., 2004), most of the time opposing mainly two position: the objectivist view for which, since Plato, beauty is a property of an object that produces a pleasurable experience in any suitable perceiver, and the subjectivist view for which, since the Sophist, the perception of beauty is an idiosyncratic function of the perceiver that is not possible to confine in discrete boundaries (Tatarkiewicz, 1970; Kubovy, 2000).

2.2. The sense of beauty

One way or another, it seems however undeniable that human beings have something as a “sense of beauty” (Santayana, 2019). Charles Darwin wrote about beauty as an *instinctive sensation* (McManus, 2011), and he associated the pleasure derived from certain elements of perception (e.g., color, forms, sounds) to a *sense of the beautiful* (Darwin, 1874) [emphasis added]. The assumptions that often come along with the proclaimed existence of such sense of beauty concern not only the idea that it is shared by everyone, but also that it feels to be a natural capacity: “Beauty is really as obvious as blue; one does not have to work at seeing it when it is there” (Danto, 2003, p.89). Furthermore, despite the famous Latin proverb “*de gustibus non est disputandum*”³ which states that there is no reason to discuss about taste, it is utterly true that often “people readily make judgements of beauty, be it of art objects or natural objects, and those judgements just feel correct” (McManus, 2011, p. 174), as if “our brains evolved to find some objects universally beautiful (Chatterjee, 2014b, p. 64), in the sense that

³ Translation: taste cannot be debated.

humans share this sense of beauty. In this regard, some theoretical models divide the aesthetic experience into two main macro-phases, in which the first one concerns an initial perception and grouping of many formal features (from which a first feeling of attractiveness and beauty may derive) that occurs automatically, and that creates an initial impression of the overall interaction (Cupchik et al., 1994; Chatterjee, 2011; Locher et al., 2010; Graf & Landwehr, 2015; 2017; Van Geert & Wagemans, 2020). Norman (2004; 2007) calls this first impression *visceral beauty*, an automatic hard-wired process which is not reflective nor influenced by previous experience. Similarly, Reber et al. (2004) also define beauty as a “pleasurable subjective experience that is directed toward an object and not mediated by intervening reasoning” (p.3). Overbeeke and Forlizzi (2020), in turn, claim that we have a natural response to products even in the absence of significant interaction. In support of the existence of two different processes, Cela-Conde and colleagues (Cela-Conde et al., 2013) show that aesthetic judgement involves two distinct phases: the formation of an early and anticipated impression, and a subsequent evaluative categorization. They argued that there are two systems related to aesthetic perception, an initial one (*initial aesthetic network*) and a subsequent one (*delayed aesthetic network*). These conclusions seemed to be consistent with the results of other previous studies (Locher et al., 2007; Winkielman & Cacioppo, 2001). Leder and colleagues (Leder et al., 2014), in turn, investigated the influence of cognitive mastering and affective-emotional states on judgements related to art experiences, using psycho-physiological measures (e.g. facial EMG). The results showed that spontaneous physiological reactions reflected the valence of works of art, but the expert participants then gave different evaluations, suggesting a difference between the initial emotional response-impression, and the subsequent modulation due to cognitive reflection.

Therefore, if an aesthetic sense of beauty exists, where does this sense come from? Evolutionary thesis that stems from Darwin (1859) see the development of this aesthetic senses as a form of adaptation (Pinker & Ullman, 2002): for instance, the preference for the symmetry of attractive faces (sign of good health) may have been abstracted and then transferred also to artifacts (Rhodes, 2006). Similarly, Hekkert (2006) proposed the by-product hypothesis according to which our aesthetic sense is, indeed, a by-product of other adaptations, primarily of our sensory systems and brain that evolved also in relation to pleasant and unpleasant sensations in response to the environment. This thesis, then, should explain why there seems to be substantial agreement on some identified features that contributes to form our preferences, as it is for balance and goodness of form (Fechner, 1876; Arnheim, 1974; McManus, 1980;

Gombrich, 1995, Locher, 2006), symmetry (Birkhoff, 1933; Gombrich, 1984; Grammer & Thornhill, 1994; Humphrey, 1997; Jacobsen & Höfel, 2003), or figure–ground contrast (Gombrich, 1984; 1995). Hardonk (1999), for instance, adopted Fechner’s method of production to prove if these aesthetics universals were present in artifacts from all cultures, and results supported the idea that we like simplicity and order but with a need for variety in this unity. Yet, what does this mean and what does it explain? Is this sense of beauty related to proprieties of the object itself, or is it in the “eye of the beholder”? A third account finds itself in the middle of this dilemma: the interactionist account.

2.3. The interactionist view and its derivations: novelty Vs prototypicality

The *interactionist* account considers beauty as emerging from the interaction of stimulus properties and perceivers’ cognitive and affective processes:

beauty is in the processing experiences of the beholder, but these processing experiences are themselves, in part, a function of objective stimulus properties and the history of the perceiver’s encounters with the stimulus. Hence, beauty appears to be “in the interaction” between the stimulus and the beholder’s cognitive and affective processes. (Reber et al., 2004: 18)

This modern philosophical account stands against the other two described above (§ 2.1), claiming that beauty emerges from specific patterns about the way people and objects relate (Merleau-Ponty, 1964). This perspective was already undertaken by Koffka (1940) who explored Gestalt’s implications for the appreciation of art and beauty, rejecting the idea of beauty in terms of physical properties of the stimulus. According to the Gestalt perspective, the viewer’s psychological processes and the characteristics of the artwork combine to produce an appreciation of beauty and art (Van de Cruys & Wagemans, 2011a). For Koffka (1940), a work of art is attractive as a whole, and not as a collection of pieces, since a dynamic connection between the object and the observer occurs, where the second organizes the former according to the unique type of Gestalt balancing which art may represent. According to Arnheim (1964; 1966; 1969), in turn, this dynamic connection is what produces aesthetic experiences, rather than the simple automatic and passive storage of parts of the visual field. For him, then, it is about the general arrangement of two dynamical visual forces merging together: a structured organization obtained from the image, and the patterns that the person is oriented to by his personal inclinations (Arnheim, 1974).

Particularly, given this dynamic interaction, several authors that support this account consider the feeling of beauty as emerging from a sort of anticipation for something immediately felt as novel and meaningful (Schoeller, 2015; Schoeller & Perlovsky, 2016; Van de Cruys, 2017, Sarasso et al., 2020). Armstrong & Detweiler-Bedell, for instance, state that:

beauty presages understanding before one's cognitive faculties can be certain that an object or experience will yield to any coherent conceptual representation. Beauty is not discerned. Rather, it is the felt prospect of cognitively representing and achieving processing mastery over a challenging object or experience. (2008: 305)

Indeed, also for Berlyne's psychobiological theory (1971, 1974) the main determinants of aesthetic preference were collative variables such as novelty and complexity. His inverted-U hypothesis consisted in the relationship between preference and these two components, and it consisted in an initial impression that strikes us and boosts our attention, followed by an interest that, when it becomes meaningful, rewards the observer with the relief of curiosity. This principle pairs with many other hypotheses for which the appeal of a work of art depends on the interplay of two sets of factors, as for instance the unity in variety principle (Hutcheson, 1753; Fechner, 1876; Eysenck, 1942), for which the greatest pleasure of beauty is related to the more variety and complexity as possible within a maximum of unity and order. Boselie and Leeuwenberg (1985), for instance, proved that this principle can predict the rated beauty of simple polygonal features.

Though, in contrast to Berlyne's theory, Martindale's cognitive theory (Martindale & Moore, 1988) claims that the main determinants of aesthetic preference are prototypicality or meaningfulness, in a monotonic or U-shaped fashion. While Berlyne's (1971) arousal account of aesthetic appreciation predicts people will generally prefer objects that are relatively complex, novel, and ambiguous, Martindale et al. (1988) showed that we prefer prototypical exemplars that facilitate meaningfulness, rather than collative variables. Indeed, other studies seemed to confirm this view (Whitfield & Slatter, 1979; Whitfield et al., 1983; Hekkert & van Wieringen, 1990). Particularly, the connection between familiarity and liking asserted by Fechner (1876) had a strong empirical proof by the mere exposure effect, according to which repeated exposure brings to more positive evaluations (Zajonc, 1968, 1998). Indeed, this effect has been found with a large variety of stimuli and a variety of measures (Bornstein, 1989), as well as with works of art (Leder, 2001). Nevertheless, the exact opposite tendency was found in other studies (e.g., Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977) utilizing

dishabituation (i.e., novelty preference), suggesting a countereffect of stronger habituation over repeated stimuli that would lead to preference for novelty. It has been argued, for instance, that liking decreases after a certain number of repetitions (Kail & Freeman, 1973; Van den Bergh & Vrana, 1998), or that is consistent only with simple stimuli rather than with complex ones (Bornstein et al., 1990).

All in all, these studies show that our preferences are surely shaped in many ways and grounded by the interaction between our capacities and the object features. Yet, understanding which are precisely the systematic factors underpinning these preferences is rather a complex challenge. Is it simplicity or complexity? Prototypicality or novelty? Is it more the object property or our previous experience-knowledge?

2.4. Expectations, predictive processing for aesthetic experience, and a new fluency account of aesthetic judgement

Reber and colleagues (2004) proposed that the influence of all the objective features derives fundamentally from their ability to facilitate fluent stimulus processing. According to their account, the more fluently the perceiver can process an object, the more positive is his/her aesthetic response, considering perceptual fluency as “the ease of identifying the physical identity of the stimulus” (Ibid., p. 4). Indeed, they showed that high fluency is itself hedonically marked and experienced as positive, and it draws into judgments of aesthetic appreciation unless the informational value of the experience is called into question.

Interestingly, all these assumptions are finally moderated by attributions and expectations. For the theoretical framework of the present thesis, this is a crucial point. According to this postulation, a certain event is more likely to elicit a subjective pleasurable experience if fluency is unexpected in light of the person’s processing expectations. Specifically, this does not mean that our preferences are related only to unexpected stimuli, but to the expectation itself: indeed, continuous fluently stimuli may bring pleasure even if they are expected, and that is because of its fluency attribution – entailed by the expectation to that specific stimulus (Shwarz, 2004a; 2004b). Remarkably, this expectation-attribution aspect of the fluency account would solve the opposition between Berlyne’s and Martindale’s theory. Indeed, on one hand, Martindale’s (1984; 1988) proposal about the relation between prototypicality and attractiveness could be evidently traced to the ease of processing fluency (i.e., prototypical stimuli are evaluated more positively because they are easier to process, as

for any variable that increases liking because of its processing fluency). On the other hand, Berlyne's inverted U-shape for beauty could be related to the un-expectancy of fluency, that is: the tension from the arousal-increasing due to novelty and complexity (which means a decrease in fluency) followed by a feeling of pleasure for the relief of curiosity, it would be as if a stimulus expected to be difficult turns out to be, unexpectedly, perceptually fluent (Gombrich, 1984). Furthermore, this relief sparked by complexity, and that brings to a pleasurable understanding, could be seen also as an increase of conceptual fluency, as if the aesthetic preference would actually be related to meaningfulness, rather than to complexity per se (Martindale et al., 1990). It would be, then, as if pleasure is due to the ability to resolve an uncertainty, i.e., rectifying the violation of an expectation (Kubovy, 1999).

This view of solving a temporary uncertainty can be associated with those theories that link the sense of beauty to the predictive processing account (Sarasso, Neppi-Modona, Sacco, & Ronga 2020; Schoeller & Perlosky, 2016; Perlovsky & Shoeller, 2019; Van de Cruys & Wagemans, 2011b). The core idea of these accounts belongs to the assumption that aesthetic emotions (as all the main basic emotions) are related to satisfaction or dissatisfaction of drives and instincts (Grossberg and Levine, 1987). Specifically, the sense of beauty would come from the satisfaction of a knowledge instinct that leads to improvement of mental representations, thus maximizing their correspondence to objects and events in the world (Perlovsky, 2014; Sarasso et al., 2020). Hence, in this view, the pleasure that comes from the relief of solving uncertainty (e.g., when something, a stimulus, is not immediate fluency perceived but later it is well understood) would be then associated to the intrinsic human tendency to maximize the similarity between our knowledge and the novel information, and thus updating our representation of the world with the minimization of the sensory uncertainty (Friston, 2010). This latter, indeed, may be associated initially with unpleasant and negative affect, so that the transition from this initial state to a subsequent state of increased predictability will be associated with an affective reward which, in turn, influences our aesthetic appreciation (Van de Cruys & Wagerman, 2011b). In Empirical Aesthetics, the research in regard to the role of ambiguity (i.e., the perceptual-sensory and content-meaning challenge elicited by an artwork, see for instance Berndt & Koepnick, 2018) can represent an example of this process. Indeed, some studies have shown that ambiguous artworks are found more interesting and preferred over non-ambiguous ones, even if harder to process (Jakesh, Leder, Foster, 2013; Jakesh & Leder, 2009), indicating that the dynamic gain of insights due to the resolution of ambiguity may affect positively the aesthetic appreciation of art (Muth & Carbon, 2013; Muth et al.,

2015). Specifically, in engaging with art, it may be the situation itself that challenges our sense-making, offering multiple possible meanings, that can generate aesthetic pleasure and interest (Muth & Carbon, 2024). Thus, the pleasure derived from aesthetic experience with art may be matched with the pleasure attributed to meaning-making by predictive processing accounts, and the distinctive power of art would consist in the degree to which the aesthetic encounter can bring this process, being it more successful than ordinary everyday experiences (Frascaroli et al., 2024). Predictive processing, therefore, can contribute to cast new light on the formation of aesthetic pleasure, and perhaps on the overall scope of aesthetic experience if we consider that “the twist offered by art (and possibly all encultured niche construction) is that architects and artists, musician and poets afford us additionally and very refined possibilities for self-restructuring and structuring of our sensed world” (Van de Cruys et al., 2024, p. 9).

Most recently, a revised version of the above-described fluency account of aesthetic judgment has been proposed, incorporating insights from predictive processing theories, precisely in relation to perceivers’ expectations and epistemic goals (Yoo et al., 2024). This new model highlights the impact that expectations (about the stimulus and about the fluency itself) may have on fluency due to many factors such as social norms, expertise, and reputation, which accordingly change the processing fluency and the outcome of aesthetic experience. For instance, empirical evidence show that individual preferences may depend on how the majority behaves or thinks (Cialdini & Goldstein, 2004), and this occur even if the stimulus is unambiguous (Yoo & Winkielman, 2023). In addition, the way we prepare ourselves for the experience of art may itself be embraced by certain expectations which already predispose our interaction and consequential responsive behavior-action before the perceptual activity even starts (Pelowski & Akiba, 2011; Leder & Pelowski, 2023). Furthermore, in regard to our epistemic goals, the model considers crucial the value and the direction that we associate with fluency and certainty of the aesthetic interaction. For instance, if our goal is to reduce uncertainty, the higher the fluency is, the more positive affect will be elicited, as the original fluency theory assumes. Conversely, if our goal is not to have clear interpretation but rather just to think about a possible one, we will prefer disfluent stimuli that remains open to interpretation, and thus we will like for instance ambiguous art such as pieces by Magritte, De Chirico, or Esher (Yoo et al., 2024). In sum, the revised conception of a fluency account in light of predictive processing assumes that “people are not only updating their beliefs, but those beliefs have motivational relevance. Therefore, if updated beliefs are in line with their goals,

people feel positive, but if updated beliefs frustrate their goals people feel negative” (Ibid., p. 6).

Finally, similar to how predictive processing associates aesthetic pleasure with the creation of meaning that succeeds in resolving an initial uncertainty, the balance between the fact that we like what we know but at the same time we appreciate even more what is new if we can reconnect it and merge it with what we know, is accounted by the Most Advance Yet Acceptable (MAYA) principle for design (Loewy, 1951). According to this principle, the right balance between innovation and typicality is what produces the highest level of appreciation and pleasure, and this has empirically been tested in design studies (e.g., Hekkert et al., 2003). Similarly, some authors ascribe the peak shift principle as underpinning our aesthetic experience (Martindale et al., 1990; Ramachandran & Hirstein, 1999), associating our preferences with the reward of learning something that goes slightly beyond what we know.

Therefore, in the light of what has been said so far, aesthetic pleasure derived from art could be considered as essentially belonging to a successful classification, interpretation, and understanding of something new (Leder et al., 2004; Leder & Nadal, 2014; Pelowski et al., 2017). Nevertheless, it is crucial to highlight the fact that, even if we seem to like stimuli and objects that are new but still possibly understandable as typical of their kind, what is novel and/or typical could always differ across individuals and cultures. As it happens with preferences for faces (Rubenstein et al., 1999), the acquisition of new prototypes will be incorporated in relations to what is already averagely and prototypical, which in turn, depends on the person’s culture and social environment (Workman et al., 2021). What has become biological is in the end the result of a history that has been fixed in a culture by socialization within a specific environment, which in turn, it brings to shared processes of preferences, as it is for instance the case of fluency (Reber et al., 2004; Yoo et al, 2024). Our preferences are rooted in what was deemed pleasant or painful, a reward or a punishment, in results from an evolutionary process where genes specify the (pleasant or unpleasant) objectives for behavior (Rolls, 2011). Aesthetics, then, should be accounted as the historical combination of the evolution of our brains in relation to the interactions between our affective (emotions), cognitive (decisions), and motor (actions) processes in relation to what is advantageous for us, which consequently contributed to form what we like and/or dislike, namely, our preferences.

2.5. Creation of meaning

Above all, regardless of the underlying principles, people can still differ with respect to the things they perceive, to their experience, and to their knowledge, thus leading to a variety of aesthetic preferences (Hekker & Leder, 2008). In art, for instance, appreciation may differ significantly between expert and non-expert (Perillo & Mastandrea, 2023; Leder et al., 2004; Leder et al., 2014), and this difference may indeed be related to individual knowledge-experience, which in turn entails different constructions of meaning. The role of these factors can influence the success of our aesthetic encounters. Dolese and Kozbelt (2020), for instance, suggest how the construction of meaning that we make in our aesthetic experience with visual art is based on the same principles that Grice (1975) ascribes to communication, which can be summarized in four conversational maxims: quality (it must be sincere), quantity (it must be informative), relationship (it must be relevant), and manner (it must be clear). If one considers the aesthetic experience in terms of a conversation between the artefact (which in turn is an extension of its creator: Newman et al., 2014) and the observer, they can be equivalently translated to the field of visual art: quality concerns the sincerity and skill of the artist's expression, quantity lies in conveying an appropriate level of visual complexity, relationship consists in the ability of an artefact to be relevant, salient, and meaningful to the experience of the other, and manner reflects the way in which the stylistic aspect succeeds in conveying the intended meaning (Dolese et al., 2014). When a viewer feels an aversion or a negative reaction towards a work of art, this might not be due to a specific objective content, but rather, to the violation (or non-observance) of the maxims just described (Leder & Pelowski, 2024), preventing the viewer from establishing an effective interaction and provoking aversion and hostility (Silvia & Brown, 2007). In this view, for lay viewers the lack of a strong aesthetic experience it is not a matter of not having a specific education to understand the work, whereas, it is just about not being able to extract from it something meaningful to him or her, as if the interaction could not be successful without a sort of personal connection, a meaning that makes it relevant on the basis of one's own interests, experiences and knowledge. The process of constructing meaning can be favored even by small pieces of information: the simple addition of a title can create a greater resonance of the work on the viewer, who will automatically associate and interpret it on the basis of his or her personal experiences related to the described theme (Cupchik et al., 1994; Seifert, 2001; Gerger & Leder, 2015; Mastandrea & Umiltà, 2016). Even with abstract art there is empirical evidence which suggest that providing a short 50-word description can aid understanding of the work and increase its enjoyment (Russell,

2003), thus supporting the accounts for which aesthetic appreciation comes from a reward process due to acquisition of knowledge, i.e., an update of one's own mental models and representations by learning something new (Schoeller and Perlovsky, 2016; Sarasso, Neppi-Modona, Sacco, & Ronga, 2020; Van de Cruys and Wagemans, 2011b).

All in all, with the theories and research discussed in this chapter, I tried to make a very short and general overview of the main core ideas that the field of Empirical Aesthetics has proposed about the appreciation of beauty and the origins of our preferences. Historically, it has been argued that it exists something as a “sense of beauty”. In our interaction with the external world, this might involve our perception from the very first impression, modulated by the ease of fluency, but mediated by our expectations and goals. The resulting pleasure could be thus connected with these elements, and particularly with the knowledge instinct to discover, understand, and learn something new that we can though still interpret and associate with our previous knowledge and individual experience, allowing us to assign a meaning to it according to our distinctive socio-cultural dimension.

CHAPTER III

THE PARALLELISM BETWEEN AFFORDANCES AND AESTHETIC EXPERIENCE

In the first two chapters it has been shown that both affordances and aesthetic experience are perceptual processes that share the fact of being characterized by certain core elements, among which there are: previous knowledge-experience, physical features of the object/stimuli, expectations, goals, and construction of meaning. In this chapter I will try to aggregate explicitly this parallelism in regard to some specific arguments, and, in accordance with the theoretical framework of my project and the respective empirical studies that were conducted, I will stress on two crucial aspects: the role of aesthetic attractiveness for the activation of affordances (specifically, in relation to everyday objects), and the role of motivations and goals of actions (specifically, in favor of the environment) in relation to the aesthetic experience of art. Finally, I will try to mitigate the two main points that could apparently separate the concept of affordance from that of the aesthetic experience, namely, the lack of action and functional interest in the latter, showing how this difference may be considered way more nuanced than it seems.

3.1. Theoretical foundations

As already discussed, affordances from an embodied cognition perspective, and the aesthetic experience for Empirical Aesthetics, are two perceptual phenomena consisting in an interaction between subject, object, and context (Jacobsen, 2006; Pearce et al., 2016; Borghi, 2018), involving a complex interplay of sensory-motor, emotion-appraisal and knowledge-meaning processes (Chatterjee & Vartarian, 2014; Nadal & Vartarian, 2022; Chong & Proctor, 2020; Rietveld & Kiverstein, 2014; Kiverstein & Miller, 2015). Therefore, both phenomena are influenced by specific features of the objects (Jax and Buxbaum 2010; Kalénine et al. 2014;

Osiurak et al., 2017; Bub et al., 2018; Tucker & Ellis, 1998; Norman, 2002; Fechner, 1986; Berlyne, 1971; 1974; Martindale, 1988; Reber et al., 2004), individual characteristics of the viewer (Sarasso et al., 2020; Pearce et al., 2016; Arnheim, 1974; Cisek, 2007; Gianelli et al. 2013a; Constantini et al., 2011a,b), and the influence of the context (Mastandrea, 2022; Mastandrea et al., 2021; Leder, 2013; Scorolli et al., 2017; Constable et al., 2014, 2016; Borghi et al., 2012; Yoon et al., 2010; Kalénine et al. 2014; Buccino et al., 2009; Borghi & Riggio, 2015; van Elk et al. 2014). Importantly, the outcome of these interactions is not ascribable only to one of these components, but to the specific and unique combination of them. This means, for instance, that the perception of something as familiar will result from a mix between the physical proprieties of the object and the knowledge-experience of the subject, embedded within a specific social and cultural context (Hekkert & Leder, 2006; Jacobsen, 2006; Borghi, 2018). Specifically, what happens in both phenomena is a continuous and dynamic bottom-up/top-down interaction between the properties and functionality of the artifact, and the user's sensory-motor-perceptual processes (Locher et al., 2010; Cisek, 2007; Leder & Nadal, 2014). In both cases, there is an initial impression due to the vision of the object-stimulus which activates attention in both directions⁴, and generates a first aesthetic impact, as well as a spectrum of affordance possibilities. Interestingly, Dewey (1958/1929) already had argued that perception is an acknowledgment of unattained potentialities for interaction, in the sense that we *see* and perceive also the choices that we don't make. Then, as the experience progresses, the attraction and reflection on the object-artifact will present continually changing action driven affordances which, in turn, will convey and modulate the rhythm, timing, flow, and feel of the interaction (Locher et al., 2010; Djadadiningrat et al., 2004; Leder et al., 2014).

3.2. Neural processes

In terms of neural systems and processes, distinct activations occur and then inevitably connect with each other, and this also may occur in a similar way for both phenomena. Borghi and Riggio (2009; 2015) showed the distinction between stable and variable affordances, whereby the former relate to the more stable information of an object such as shape or size, while the latter are more related to variable information such as hand movement or orientation. *Stable affordances* are represented in the ventro-dorsal route (reaching and grasping), whereas

⁴ Attention can be of two types: an endogenous one, i.e., directed voluntarily through a top-down process (Posner et al. 1978), and an exogenous one, i.e., reflexively and automatically driven by the stimulus through a bottom-up process (Posner & Cohen 1984).

variable affordances in the dorso-dorsal system (online control and action information) (Rizzolatti & Matelli, 2003; Sakreida et al., 2016). Interestingly, the first one is a bilateral system that may operate independent of conceptual knowledge (Cant et al., 2009), whereas the second is a left-lateralized system which employs conceptual knowledge (Borghi & Riggio, 2015). Nevertheless, the authors crucially specifies that two systems (and the respective aspects of affordances activation) are deeply interconnected, and thus “it is indeed possible that all affordances are automatically activated, and that a competition among them is differently solved depending on the task and the stimuli” (Ibid., p. 13). This distinction between the automaticity of a first system that perceives without the intervention of knowledge and a subsequent process that involves a reflection for choice, recalls Norman’s (2004) distinction between visceral, behavioral, and reflective beauty, where only the last one (reflective) is enriched by our past experience. Likewise, as already mentioned, several models of aesthetic experience make this distinction (e.g., Cela-Conde et al., 2013; Jacobsen & Höfel, 2001; 2003).

Furthermore, as for the emergence of affordances, in the course of the evaluation of the sensory input, emotional and cognitive processing cannot be completely separated (Pessoa, 2008). The pre-frontal cortex (PFC) receives highly processed and integrated sensory information, which are useful for higher order meaning making processes. The responses reflecting an item’s significance will then be a result of simultaneous top-down modulation from frontoparietal attentional regions and emotional modulation from the amygdala, basal forebrain, orbitofrontal cortex, and other regions (Pessoa, 2010). Similarly, affordance competition between potential actions in the frontoparietal system is influenced by various other brain regions such as the basal ganglia (Redgrave et al. 1999) and the pre-frontal cortex (Miller, 2000; Tanji & Hoshi, 2001), and there is no rigid temporal sequence on how decisions occur in the frontoparietal system, meaning that connections are bidirectional and the influence on the choices-competition can occur between variables processed by different regions (Cisek, 2007).

In sum, in both interaction phenomena occurs first an immediate perception (probably not mediated by any reasoning) that works as a sort of anticipation, where a first emotional impression is formed, as well as a range of possibilities for further interpretations and actions. Subsequently, bidirectional and multi-areas processing continuously takes place between affective-evaluative and cognitive-reflective systems, which will finally bring to an evaluation-decision.

The existence of these two stages in both perceptual phenomena is the starting point for the core purpose of this chapter, namely, to show how the respective peculiarities related to both processes can shed new light on each other, specifically: the factors underpinning aesthetic attraction as theorized in Empirical Aesthetic can give new insights into the affordance activation in regard to the first impression-phase, whereas the role of motivation and goal-directed actions for affordances can contribute to nuance the relation of an aesthetic experience with purposiveness and functionality.

3.3. Object attraction and the anticipation for interaction: a proposal for the role of emotions and beauty

As discussed in the previous paragraph, the generally accepted view is that the affective dimensions of a visual item are reflected at multiple processing stages, from early visual areas to prefrontal sites, hence, the emotional signals are elicited so as to prepare the agent to enact, facilitating action-selection during the development of strategies for the reduction of its uncertainties (Pessoa 2008; Heilman et al. 2010; Rolls, 2011). In this sense, the emotional-affective response represents a sort of anticipation signal. Notably, emotions can deeply and significantly affect key elements of cognitive processes (Baumeister et al., 2007; Damasio & Carvalho, 2013; Duncan & Barrett, 2007; Okon-Singer et al., 2015), regulating our inner state in such a way as to prepare it for a specific interaction (Damasio, 2000). Thus, they influence our goals and needs, modulating the resulting behavior (Brehm et al., 2009; Nelissen et al., 2007), and providing us with functionally useful information for the evaluation of a given context, and the consequent action within it. Therefore, emotions may serve as an intrinsic motivational state (Murayama et al., 2010; Oudeyer et al., 2016; Schmidhuber, 2010), favoring the interaction with the environment (Perlovsky, 2014; Perlovsky & Schoeller, 2019; Schmidhuber, 2009; Schoeller & Perlovsky, 2016). In view of these considerations, it is evident that the success or not of this anticipation may depend on the type of emotions involved in the experience. In terms of affordances, what can be determinant is the interdependence between the emergence of the emotional reaction and the anticipation of a given choice or action goal, the achievement of which will thus be conditioned by the intensity of the aesthetic emotion, i.e. the strength of its aesthetic value (Xenakis et al., 2012). The valence of the aesthetic interaction would function as a recommendation mechanism of the interaction itself, assigning a value to the context and thus to the eventual possibility of acting in it, expanding and optimizing our ability to detect the *interactive affordances* (Xenakis & Arnellos, 2013). Hence,

a positive first impression of a product is essential if there is to be any further interaction with it, because the anticipatory system facilitates the agent in action selection (Xenakis & Arnellos, 2014).

This mechanism could have an important and decisive implication for the activation of affordances when the aesthetic emotion in question is related to beauty. If the positive outcome to find something beautiful and attractive at a first impression (either in art or with objects) does indeed act as a signal to capture our attention, automatically activating and conditioning our positive judgement and thus the resulting aesthetic emotions, therefore, it could be hypothesized that beauty may play an important role in activating affordances and, in turn, in influencing our behavior. In this sense, the role of beauty is not confined as an objective property, rather, as a discrete response by the viewer to something they see in those objects and in their interaction with them (Frohlich, 2004). Furthermore, given the role that past experience and mental models have in within our interactions, predictive processing accounts would suggest that the observer will focus on those inputs leading to the highest learning progress, avoiding those that are overlearned or purely random (Schmidhuber, 2010; Van de Cruys, 2017). The experience itself and its anticipation appear to be served by dopamine release in distinct regions of the striatal system, underlining the important role of individual beliefs and expectations (Salimpoor et al., 2013; Salimpoor & Zatorre, 2013). The interaction is then monitored and directed by a central executive that directs voluntary attention to the artifact in a cognitively driven top-down fashion (Loecher et al., 2010).

In sum, the perception of beauty may be considered as a motivational force, an anticipation that attracts our attention, turns things salient to us, and intercedes with our goals. The aesthetic experience of beauty motivates the agent to seek situations for which those signals are positive and rewarding. This is what is called the motivational tendency of aesthetic experience (Xenakis & Arnellos, 2015): “we suggest that a minimal aesthetic experience should be considered as an aesthetic emotional evaluation that forms an anticipation for a certain interaction, thereby reducing the interactive uncertainty” (p. 10).

3.4. The importance of aesthetic attractiveness for everyday objects affordances: theoretical premises for Study 1 – “Aesthetic experience and Affordance”

We know that objects affordances clearly do not only concern motor skills, cognitive processes and object-related functional meanings, but also emotional processes (Overbeeke &

Wensveen, 2003; Caravà & Scorolli, 2020; Kiverstein & Miller, 2015). The whole mechanism described above can be of crucial importance for the activation of affordances by everyday object. Indeed, since our aesthetic feelings in respect to the attractiveness of the inputs around us may have a functional significance in driving our day-to-day activities (Rolls, 2015; Xenakis et al., 2012), it is important to consider how emotional and cognitive processes are regulated by our aesthetic appreciation when we interact with the environment.

Righi et al. (2014) evaluated with ERPs the relationship between affordance perception and aesthetic appreciations of objects, and they found a link between the two (indexed by N1). Specifically, highly attractive objects that are also perceived as highly functional, engage a privileged neural activation (i.e., strong response for N3, P3, and LPP). Then, in another study they investigated how the attraction to highly attractive stimuli may influence cognitive processes such as perception, attention, decision making, and response selection (Righi et al., 2017). They found that the aesthetic pleasantness of the stimuli prompts extraction, detection, and storage of sensory features in short-term memory, and it also shortens response selection times, thus showing that our preferences (or beauty) may foster the overall interaction. Furthermore, their results suggest that the high attraction of the stimuli is always processed as emotionally significant (indexed by the anterior P200), and it can improve voluntary attentional allocation toward high-order processes such as categorization and decision signal. These findings seem to confirm the hypothesis that affordance perception couples with the subjective experience of attractiveness, and that this latter facilitates the interaction with everyday objects (Cunningham, 1986; Cunningham et al., 1995; De La Rosa & Suarez, 2015; O'Doherty et al., 2003), probably and mostly through an attention-mediated process (Pizzagalli et al., 1999). Similar conclusions are confirmed in other studies that show a positive correlation between aesthetic appreciation and behavioral indexes of attentional enhancement (Ronga et al., 2018; Sarasso et al., 2019).

In sum, attentional facilitation in perceptual processing and emotional activation may be useful to elicit faster motor responses toward those aspects of the environment that could be of benefit to the subject. These conclusions are crucial and propaedeutically important to understand the theoretical framework according to which we implemented our empirical study on affordances activation by everyday objects made of sustainable or non-sustainable materials (Study 1 – “Aesthetic experience and Affordance”). Indeed, we decided to test how the coupling between affordances and aesthetic attractiveness could be applied to environmental issues. Specifically, we compared action readiness activated by wooden and plastic everyday

objects, thus opposing the novelty and aesthetic attractiveness of the first, with the familiarity of the latter, given that usually familiar stimuli are processed faster than novel ones (Reber et al., 2004; Haber & Hershenson, 1965; Jacoby & Dallas, 1981). Righi and colleagues (2014; 2017) showed a correlation between attractiveness and faster responses (i.e., between aesthetic pleasantness and affordances), though, that was found mainly in relation to highly functional engaging objects. The change of material, instead, may entail also a change in the object's functionality, as in the case of our study. Furthermore, as already argued, the context can be crucial for the modulation of our experiences, both for affordances (Borghi, 2018; Raymond et al., 2017) and for aesthetics (Mastandrea, 2022). For this reason, to measure affordances we adopted a paradigm (Constantini et al., 2011a; Ambrosini et al., 2012) that takes into account the physical (i.e., the object distance from the perceiver) and the social-linguistic (i.e., command verbs) contexts, expecting different outcomes for each specific condition (see the full report of the study in Chapter V for more details).

The aim of this paragraph was to highlight how aesthetic attractiveness and novelty of objects can play a crucial role in enhancing our affordances toward them, which represents the theoretical premise for our investigation on sustainable materials implemented in the first empirical study of my project. This then concerned an initial phase of aesthetic experience. The two subsequent empirical studies, instead, are focused on two following steps, namely, the interplay between emotions and motivations, and the affective and cognitive processes that may bring to deep reflection and eventually influence our actions in terms of reasoned choices, so to explore how the aesthetic experience with art can modulate our interaction with the environment by adaptively guiding our behavior (Rolls, 2014; 2015; Xenakis & Arnellos, 2015). Hence, whether the first study concerns aesthetic experience in relation to everyday objects, the next phases are investigated in regard to art. In the next section, I will try to argue on how our decisions and actions may be influenced by the affective and cognitive processes related to the experience of art, focusing particularly on the role of function-goals, expectations, and motivations.

3.5. Action and goals in aesthetic experience

In Chapter I it has been synthetically introduced how the 4E accounts of cognition have brought up to date the classical theories of perception (see §1.4). As discussed, empirical studies on embodied cognition developed a reconceptualization of affordances, showing how

our perception is grounded in our bodies. Enactive accounts, in turn, postulated that we perceive the world in terms of perceptually guided actions (Varela et al., 1991). The discovery of canonical neurons in monkeys (i.e., neurons activated by the mere observation of objects, not by actions, independently from the fact that the object will be grasped) opened up new trajectories (Sakata et al., 1995; Murata et al., 2000), and the neural motor simulation found in humans (Gallese & Lakoff, 2005) signed a breakthrough in the neuroscientific literature of affordances (Borghi, 2018). Research on embodied simulation (Gallese, 2018) showed also that an activation of the motor cortex may occur due to the simple observation of a movement reproduced by a work of art (Freedberg & Gallese, 2007), even with abstract art, through the imagination-simulation of the gesture that produced that artworks (Umiltà et al., 2012; Leder et al., 2012; Sbriscia-Fioretti et al., 2013). Embodied simulation shows, then, that an aesthetic experience is related to the bodily feelings triggered by artworks, and how this latter is experienced also in terms of motor representation. In other words, this tells us that, at least in terms of neural activation, our perception of the external world is connected with motor act also when we see art. Findings of studies using TMS, for instance, show evidence of the preliminary contribution of motor and premotor cortices in aesthetic evaluation (Calvo-Merino et al. 2010; Cazzato et al. 2016), thus supporting a role of these brain motor areas in mediating preference for bodies and art (Cattaneo, 2020). Indeed, some scholars claim that many cognitive abilities such as the perception of objects are intimately organized in terms of goal-directed motor acts (Gallese et al., 2009; Gallese, 2018).

Though, this aspect has always been tackled when it comes to the experience of art, for which it is said to be characterized by the lack of a specific function-goal in terms of action, i.e., it is non-utilitarian (e.g, Brattico, 2019; Brattico & Pearce, 2013; Chatterjee, 2003; Scherer & Zetnet, 2008; Schindler et al., 2017). Nevertheless, given the strict connection of our perception with action that was just discussed, it is probably inevitable that a motor activation of any sort occurs even within an aesthetic encounter with art. Further, besides the implicit motor simulation that may occur, other scholars suggest that, rather than a lack of action, it should be probably more appropriate to assess that what happens in the aesthetic experience is an inhibition of action (Scarantino, 2022). According to this view, rather than action tendencies that predispose to act in a particular way, we should talk of “modes of action readiness” (Ibid., p. 7) and think of emotions as modes of relational action preparation-dispositions that may develop, maintain, or break a relationship with the environment, but they can also either manifest as mode of relational readiness per se (Frijda, 1986). The core point of this difference

would be that not all emotions produce action tendencies, but they all produce modes for action readiness. When we experience emotions and feelings with art, being a painting, a movie, or a piece of music, the lack of action does not mean that the stimulus does not involve modes of action readiness, rather, we are just actively inhibiting it because it does not concern our goals in that specific moment (Scarantino, 2022). Furthermore, modes for action readiness are not just bodily but also mental: positive emotions elicited by artworks involve mental action readiness like the will to contemplate its features, to know more about it, to take a picture of it, to desire to possess it, to buy a copy, and many others (Menninghaus et al. 2019). This inhibition is thus somewhat voluntary, and it depends on our motivations, which are in turn evidently related to our goals and expectations. The relationship and influence between emotions and the motivations to pursue our goals is somehow bidirectional, and the intensity of both is the crucial aspect for success or failure of the aesthetic experience (Rolls, 2011). Indeed, the outcome of this interplay may include either approach or avoidance (i.e., willingness to end or to keep/repeat the exposure).

Graf & Landwehr (2015; 2017) developed a model called the Pleasure-Interest model of aesthetic liking, which is based on the distinction between two forms of processing: one automatic, stimulus-driven, and the other one which is more controlled and perceiver-driven. The first process regards those cases when aesthetic judgments are faster and more automatic, based primarily on pleasure or displeasure responses to stimuli (the one we have already largely discussed and that it can have the role of anticipating the prosecution of the interaction). In the second, instead, a controlled processing mode becomes engaged, eliciting aesthetic interest, but only if motivation is sufficient for this process to happen (Graf & Landwehr, 2017, p. 3). This model found support in other studies concerning visual preference (Miller & Hübner, 2019; Van Geert & Wagemans, 2020). Thus, processing motivation should be counted as a key factor for aesthetic pleasure. This point could be of crucial importance because it allows to solve the opposition for which we might either like ease of fluency (Reber et al., 2004; Martindale, 1988) as well as a degree of challenge and complexity (Berlyne, 1974; Hekkert & Leder, 2006), explaining these as two forms of liking, namely, a pleasure-liking and an interest-liking (Nadal & Vartarian, 2022). Furthermore, this view would place in line with all those models that propose a distinction between two processes (see §2.2), and it also somewhat confirms both the role of aesthetic experience as anticipation and motivational tendency for interaction (Xenakis & Arnellos, 2015) by increasing attentional engagement and curiosity (Ronga et al., 2018; Sarasso et al., 2019; Barbieri et al., 2023; Kirsch et al., 2016; Leder &

Nadal, 2014), as well as its connection with knowledge and learning (Sarasso, Neppi-Modona, Sacco, & Ronga 2020; Perlovsky, 2014; Perlovsky & Schoeller, 2019; Schmidhuber, 2009; Schoeller & Perlovsky, 2016) when a sort of challenge-for-novelty is faced (Van de Cruys, 2017; Reppa & McDougall, 2015).

3.6. Aesthetic experience is not disinterested

All in all, the assumptions described so far support the idea that aesthetic experience is crucially dependent on our motivations and that it cannot be intended as completely disconnected from action. As Shusterman (1999) once suggested, aesthetics should “end the neglect of the body that Baumgarten disastrously introduced” (p. 301) and study the use of one's body as a locus of sensory aesthetic appreciation (*somaesthetics*). This consideration brings, in turn, to a critical view of those accounts that associate the research for empirical evidence of aesthetic experience to Kant's (1794/1790) theory of disinterested aesthetic pleasure, namely, that this kind of pleasure does not concern the satisfaction of our interests, and it does not lead to any desires to act, but rather just contemplation (Carroll, 1996)⁵. Notably, this view is supported by different important emotion theorist (de Sousa, 2007; 2011; Sherer, 2005; Ramachandran & Hirstein, 1999), and many researchers in empirical aesthetics and neuro-aesthetics have suggested that aesthetic pleasure lacks such a motivational stance (e.g., Christensen, 2017; Deacon, 2006; Scherer, 2005), acknowledging that this belief is obviously directly inspired by the philosophical concept of disinterest (Chatterjee, 2003; Chatterjee & Vartanian, 2014, 2016; Pearce et al., 2016; Schubert et al., 2016). Though, for other scholars (Menninghaus et al., 2019) aesthetic experience involves in many ways our bodily action readiness, such as orienting towards the artwork, be exposed to it at length, emulate it, smile, manifest excitement, recommend it, and so on. Indeed, in their work, the last bullet point describing what are aesthetic emotions concerns the fact that they “include motivational tendencies of approach or avoidance, most notably the tendency to end, extend, or repeat exposure, and in some cases also the wish to possess the eliciting object” (Ibid., p. 186). Furthermore, they precisely cite Kant (1790/2001, p. 107) to point out that the philosopher himself defined beauty as something that reinforces and reproduce observation, which is

⁵ In reporting this general idea, I invite the reader to consider that this may not necessarily correspond to Shaftesbury's or Kant's notions of disinterested interest, given the clear differences in terms of the specific conceptual and historical understanding of art, aesthetics, and mind, within which those philosophers expressed their ideas.

associable to the tendency of seeking out again what we previously liked, hence, a connection between aesthetic pleasure and behavior. As Scarantino (2022) suggests, rather than say that aesthetic emotions are disinterested, we should refer to it as “differently interested” (Ibid., p. 15), since the interest may differ from those related to more common and ordinary emotions, yet it exists, either before approaching to an artwork, during its appreciation, or in both cases. Indeed, even the mere contemplation of art can:

promote interests and goals like personal growth, obtaining pleasure, avoiding monotony, meeting like-minded people, cultivating a sophisticated self-image, expanding one’s knowledge, seeing one’s values affirmed or challenged, experiencing closeness to others, experiencing distinctness from others, sharing reactions to artwork, supporting worthy causes and innumerable others. (Ibid., p. 14)

Similarly, Fingerhut and Prinz (2020) claim that aesthetic emotions have unique modes of action readiness (e.g., wonder would manifest in tendency to actively explore an artwork that has caught our attention). What, instead, should correctly be accounted to Kant (1974/1790) and which falls within the theoretical arguments brought up in the present thesis, is his concept of *dependent beauty*, namely, when an object resonates with mental structures by adhering perfectly to a concept, being exactly what the thing should be “because it perfectly satisfies the “rules” for the application of a concept” (Armstrong & Detweiler-bedell, 2008, p. 310). Dependent beauty results when the concept-bound cognition is particularly successful because the object immediately succumbs to conceptual understanding, a perceptual phenomenon that, as discussed, we can basically relate today to the processing advantage for familiarity (Martindale, 1988) and the pleasure that may come from an expected ease of fluency (Reber et al., 2004).

In sum, so far it has been argued that dynamic visuo-motor coupling (i.e., objects’ affordances) and aesthetic experience have more in common than it seems to be, since for the activation of the former it may be crucial the aesthetic attractiveness of what is perceived, and the second should not be considered as devoid of interest and actions, but rather modulated by specific types of motivations and expectations, which may bring eventually to lack of action as a voluntary inhibition. Though, what constitutes then the uniqueness of an aesthetic experience? What is the peculiarity of aesthetic pleasure? In there a real difference between aesthetic emotions and other emotions?

3.7. Is there a uniqueness for aesthetic pleasure and emotions?

Evidently, the debate that the above questions produce is yet far from an end. Berridge et al. (2009) proposed that aesthetic pleasure might be accounted for as a liking without wanting, namely, as a reward that it is not associated with satisfaction of desires. In their study they identified two distinct neural reward systems: one linked to a direct experience of pleasure (*liking*), the other linked to the desire for the object and connected with the actions necessary to satisfy that desire (*wanting*). Particularly, the first is mediated by a neurochemical system linked to the activation of opioids and endocannabinoids in the ventral globus pallidus and in the nucleus accumbens (Berridge & Kringelbach, 2015), whereas the second would be mediated by a widespread neural circuit afferent to the mesolimbic dopaminergic system (Tibboel et al., 2015), which implies the influence of emotional-motivational elements on the motor system. Thus, the authors claimed that this would also explain the phenomenon by which we may be interested in having something without necessarily liking it, and the evidence for this may be found by pharmacologically manipulating the two systems.

For instance, by suppressing endogenous dopaminergic neurotransmission, wanting can be reduced without affecting liking (Berridge, 2007; Leyton, 2010). Similarly, activation of the dopamine system through the administration of amphetamines or other catecholamine-activating drugs, it amplifies wanting without increasing liking: in this case, neural sensitization of the salience of the incentive due to drugs and linked to their abuse, can generate the compulsive desire to take more drugs, regardless of whether the drugs themselves are liked or not, thus contributing to the addiction to them (Robinson & Berridge, 2008).

Chatterjee (2014a) once suggested that these findings may correlate with the Third Earl of Shaftsbury and Kant's notion of disinterested interest, as they provide evidence that we can be emotionally invested and disinterested at the same time, which would mean that emotions which incite actions "are just not aesthetic" (Ibid., p. 2). Nevertheless, there are also empirical evidence suggesting that hedonic values for cultural objects (including art) engage processes associated with wanting and instrumental behavior, such as reward prediction, incentive salience, biasing of decision making, and conditional learning (Skov, 2019). Studies on musical experience, for instance, showed that the peak of pleasure was associated with dopaminergic activity (Salimpoor et al., 2011), and that the degree of activity in the nucleus accumbens (one of the parts that should underlie pleasure, but not wanting) anticipated and predicted the willingness to pay to listen again to music, i.e., the desire to want more (Salimpoor et al., 2013). Indeed, our reward system is functionally connected to sensory processing (Lacey et al., 2011),

and the striatal dopamine systems are intricately and reciprocally connected with opioid systems in the nucleus accumbens and ventral pallidum (Salimpoor et al., 2015). Furthermore, it has been widely shown also that the valuation of music and art, as well as other objects (e.g., money) relies on the same neural mechanisms that mediate reward derived from food, drink, or sex (Batra et al., 2013; Brown et al., 2011; Levy & Glimcher, 2012; Sescousse et al., 2013; Wassiliwizky et al., 2017).

Hence, defining what is the very uniqueness of aesthetic pleasure is undoubtedly one of the major challenge for Empirical Aesthetics. To date, there is no consensus on how to precisely distinguish aesthetic emotions, or even on whether aesthetic emotions exist or not (Skov & Nadal 2020; Menninghaus et al. 2020; Robinson, 2020; Schindler et al. 2017; Fingerhut & Prinz 2020). Skov and Nadal (2020) criticized the idea of aesthetic emotions supported by Menninghaus et al. (2019), saying that those emotions are not different from other kinds of emotions in terms of psychological components or neurobiological underpinnings, and that the affective states observed during aesthetic appreciation are the same as other forms of sensory valuation. Specifically, they state that aesthetic emotions should be accounted as such only if distinct synchronization profiles involving all of Sherer's (2005) five hypothetical components (cognitive, physiological, expressive, motivational, and subjective feeling) are provided for them, and for them it is not so. In response to these objections, Menninghaus et al. (2020) specified that there are studies showing how an emotion can differ in their aesthetically evaluative variant compared to the ordinary one, as for instance for the feeling of being moved (Menninghaus et al., 2015). They claim that an aesthetic emotion is an "intuitive evaluations of various subjectively perceived aesthetic virtues or failures/vices" (Menninghaus et al., 2020, p. 650), and this implies that also those emotions that do not usually bear an evaluation can acquire such an implication by virtue of a context-driven meaning activation, they just must always have a distinct focus on aesthetic evaluation. In a nutshell, they support the idea that aesthetic evaluation-driven liking is categorically different from other types of liking and thus it may translate into a difference in subjective feeling, which will result, in turn, in an increased activations of the classical physiological indicators of emotional arousal as well as for the neural reward circuitry.

However, this definition cannot satisfy their opponents, for which the crucial point seems to be whether we can define an aesthetic emotion in a neurobiological sense or not, and they assert that many evidence suggests that aesthetic appreciation is not a distinct neurobiological process, but a general system, centered on the mesolimbic reward circuit, for

assessing the hedonic value of any sensory object (Skov, 2019). Regardless of the neural distinction, some authors claim that we can still say that there is something distinctive in terms of experience, specifically, what Frijda and Sundararajan (2007) have labeled experiential savoring, which “is typical of what they call ‘refined emotions’. Aesthetic emotions are refined in the sense that they involve highly focused attention and come with the awareness that we are having such experiences.” (Scarantino, 2022, p. 21).

3.8. Expectations and motivations: theoretical premise for Study 2 – “Aesthetic experience and Emotions”

To go further in the theoretical debate about what differs aesthetic experiences and emotions from the ordinary ones, is evidently not within the scope of the present thesis. Rather, given the premises about the role of actions and goals in our perception of the world, in the previous sections I tried to show how some classical features of aesthetic experience may be smoothed, specifically in regard to the crucial importance of individual motivation and expectations. At the same time, precisely in relation to these two elements, regardless of the existence of a unique and specific neural processing for aesthetic appreciation, it should be still possible to assert for a distinguished connotation of an aesthetic emotion, following Scarantino’s suggestion that

aesthetic experiences have a conative dimension which detaches the emoter from other compelling needs to act – what is to be done at the time of art contemplation has the artwork as its primary object. This focus on the artwork, which comes with awareness of having it, makes experiential savoring possible. (Scarantino, 2022, p. 21).

In other words, it is the way we dispose in respect of an artwork, and the way we *prepare* ourselves to receive it, what actually makes the aesthetic experience as such, and thus different from other ordinary experiences. Hence, if we would make the distinction in terms of motivations and expectations, the singularity of what aesthetic experience and emotions make us feel would be essentially linked to the way they dispose us to do and feel.

Indeed, our liking and disliking are flexible in respect to contexts, physiological states, and previous experience (Skov, 2022). Liking and wanting can be strictly connected, and the evaluation of emotional cues in artworks recruit (at least partially) the same neural mechanisms involved when we evaluate people, since in both cases various regions along the visual dorsal and ventral pathways are involved (Calvo-Merino et al. 2010; Cattaneo et al. 2015, 2017;

Cazzato et al. 2014, 2016; Ferrari et al. 2015; 2017; 2018). Hence, regardless of the existence of a specific network or not, aesthetic appreciation relies on a multitude of factors that go beyond emotional evaluation, and the importance of expectations is undoubtedly fundamental. If I go to the supermarket or to a museum, I will have different expectations of what will satisfy me. In the study conducted by Wagner et al. (2014), participants had to evaluate stimuli depicting disgusting images. Each image was described and labelled as an artistic photograph or as educational documentary material: in the results, negative emotions were almost equivalent in both conditions, but images presented as artistic were evaluated more positively. The authors' interpretation is that framing conditions activate two different cognitive schemata, which in turn stimulate different expectations and beliefs about the meaning of the image, thus leading them to affectively process the stimuli in two distinct ways. Importantly, this does not mean that participants did not experience those stimuli as disgusting, but the overall aesthetic appreciation was different because of their expectations. Similarly, Müller et al., (2010) had already suggested that the process of evaluative categorization may be intentional, that is, our aesthetic appreciation of beauty appears to require intention and is not spontaneous in character. Specifically, the impression does occur spontaneously (Höfel & Jacobsen, 2003) and it is related to the perceptual features of the stimulus and its relation to the beholder in terms of perceptual and conceptual fluency, but our final judgement will depend on many other things, depending on the way we are predisposed to it.

Our expectations and motivations, then, are essential and crucial for the shaping of our aesthetic emotions and judgements. Though, in addition to these and other individual characteristics already discussed in this thesis, the transformative outcome of an aesthetic experience will evidently differ also according to the kind of stimulus, the context, and the medium through which it is perceived (Pizzolante et al., 2024; Leder & Pelowski, 2024). The investigation made in our second study (Study 2 – “Aesthetic experience and Emotions”, Chapter VI) is somewhat related to this kind of issues. Indeed, the work can represent an example of inquiry into the relationship between emotions, expectations, and motivations, mediated and modulated by different types of context and media-instruments. We conducted a study about the aesthetic emotions of music and their different impact in relation to the context and to the way through which it is manifested, namely, between a concert experienced live in theatre, in virtual reality (VR), or on a computer. The motivational component was inherent to the type of sample related to the experience. Indeed, the study was run between different groups, with some crucial differences among the sample of the two groups who attended the

musical concert. First, participants who experienced the concert in the theatre were actual frequenters who paid for that show, hence with high expectations and motivation. On the other hand, instead, students who needed credits and experienced the concert in the laboratory (through VR or on a computer screen). Notably, music can produce a strong effect on emotions (e.g., Brattico & Pearce, 2013), and it has been shown how much cognitive expectations may predict its aesthetic pleasantness (e.g., Cheung et al., 2024). In our case, we opted for a Tango music concert, and this choice entailed other two consequential differences: the age of the attenders in the live condition (the medium age of participants attending the concert in theatre was way higher than that of students coming to the lab), and their taste and habits toward such genre of music, hence, their motivation and expectation in respect to their preferences, since young participants are definitely less used to this musical genre which is far from their typical standards (more details in the full report of the study in Chapter VI).

CHAPTER IV

COGNITIVE SCIENCE, SUSTAINABILITY, AND ART

“Experience is the result, the sign, and the reward of that interaction of organism and environment which, when it is carries to the full, is a transformation of interaction into participation and communication. [...]

Works of art that are not remote from common life, that are widely enjoyed in a community, are signs of a unifies collective life. But they are also marvelous aids in the creation of such a life” (John Dewey, *Art as experience*, 1980/1934).

In the first part of Chapter II, it has been discussed on the nature of a sense of beauty, and how this cognitively involves the impression and formation of our aesthetic encounters, which then influence on our readiness for action. Accordingly, as it is reported in Study 1 – “Aesthetic Experience and Affordance” (Chapter V), we investigated the role of aesthetic attractiveness in modulating the activation of affordances by everyday objects (in our case specifically entailed by a change in the sustainability of the material component). Further, it has been argued how aesthetic emotions are closely related to our goals, expectations, and motivations. The character of aesthetic experience will depend on the degree of intensity that the emotional outcome will sort out of this interplay, which in turn will influence our interactions and judgments (Rolls, 2011; Xenakis et al., 2012). In Study 2 – “Aesthetic experience and Emotions” (Chapter VI), we examined this aspect comparing different modalities (i.e., different tools and context) of experiencing the same music by a participant sample with distinctive individual characteristics.

For our third study, we aimed at exploring the process through which our aesthetic encounter with art may bring to actual behavior in favor of the environment (Study 3 – “Aesthetic Experience and Environmental Art”, Chapter VII). As previously anticipated, this process consists in a constant and bidirectional interaction between affective and cognitive processes. Though, when this applies to environmental issues and sustainable behaviors,

several peculiar features need to be considered. In this last theoretical chapter, a general overview of these arguments will be traced.

4.1. Affective and cognitive mechanisms

In contemporary Empirical Aesthetics, a distinction between pleasantness and meaning was already formulated by Berlyne (1971; 1974) and Wohlwill (1976), intending the first as the one that catches your attention and the second as the one that enhances your interest. Importantly, several models of aesthetic experience show how these two elements are different but at the same time part of two mechanisms which are intensively interconnected (Leder et al., 2004; Leder & Nadal, 2014; Locher et al., 2010; Oliver & Raney, 2011). Many researchers agree on the existence of two main macro-stages. Cupchik (1999), for instance, identified two modes of processing: the reactive mode, which is linked to immediate pleasantness or pleasing excitement, and the reflective mode, which is linked to meaning and the enjoyment of challenge. Already at the end of the first process, memories and emotions can activate and come into play, contributing to the first evaluation of the object (Pelowski et al., 2016). In this sense, some cognitive processes and their interaction with the affective ones are likely to occur already at first glance (Cupchik, 2020). Indeed, as already discussed, when we perceive the world around us we are influenced by a form of intrinsic knowledge that has shaped our perception and taste over time and evolution, and that it intercede with our perception and interpretation of things in relation to the similarity or not with our personal frames, which in turn, are the results of both our individual experience and the socio-cultural context. Hence, the combination of these two systems and their interaction provides an approach to understand aesthetics as rooted in evolution and the effects that this latter had on brain design and function (Rolls, 2011). Importantly then, to really carve on our actions and behavior, the power of beauty and the positive outcome of an aesthetic appreciation needs inevitably to deal with our cognitive reflecting processes, in a continuously interaction between stability and struggle, novelty and achievement, that forms the “drama in which action, feeling, and meaning are one.” (Dewey, 1980, p. 16). Notwithstanding, this whole drama always starts with a first impression, and the intensity of this initial affective-emotional response is crucial for the whole process to flow, and its effect will depend on the different modulation that it takes in relation to people’s motivations and goals (Yoo et al., 2024). In Study 3 – “Aesthetic Experience and Environmental Art (Chapter VII), we investigate how these processes in relation to the experience of art can impact our behavior outside the aesthetic domain, that is, in relation to

decisions for the protection of the environment. Specifically, we explored the role that cognitive and affective mechanisms related to the aesthetic experience of art may have on our intentions and donations in favor of environmental sustainability. More precisely, we used images of artistic plastic waste installations made in a natural context, i.e., the work of two artists who want to explicitly remark the effect of humans' actions in ruining the environment.

The effect that this particular type of art has on our emotions and behaviors is characterized by several different features, among which there are the kind of imagery it uses to communicate environmental issues (i.e., positively or negatively framed) and the individual characteristics of the perceiver in relation to both, the ecological dimension (e.g., environmental attitude and concerns) and the interest in art. Therefore, in the following sections, an overview about the psychology of climate change communication will be given, concerning its theories and the problems in respect to decision-making strategies applied for this specific issue (e.g., green nudging). Finally, I will introduce the specific characteristics of environmental art and its role in influencing attitudes, emotions, intentions, and behaviors.

4.2. The psychology of climate change

Climate change is a tough enemy to defeat, primarily because of the nature of its own entity. Indeed, with this term are meant the changes that are occurring in the earth's climate system and the impacts such changes are having on ecosystems and society (Shome & Marx, 2009). In the present thesis I will often address it with the more general expression "environmental issues", referring indeed to all those critical areas in which human society needs to do something for the protection of the ecosystem (e.g., waste, energy, food, pollution, etc.). Hence, within the scope of the present work, the two formulations can be considered interchangeable.

Environmental issues require a substantial increase in action (IPCC, 2022). According to American Psychological Association (APA), climate change demands the attention of the psychology field as this topic is highly relevant to human behavior, experience, and wellbeing (Clayton et al., 2016). Despite widespread concern about the impacts of climate change, there remains a prevalence of public ignorance, apathy, opposition, and denial regarding the severity of the risks (Gilden & Peters, 2017; Leviston & Walker, 2013). One of the main help and support that the research in cognitive science can provide to fight climate change is to study how to make as efficient as possible its communication strategies in order to increase social

engagements (Moser, 2010; Reser & Bradley, 2017), and to induce a strong impact on people's thoughts, beliefs, attitudes, and behaviors (Gifford, 2008; Weber & Stern, 2011). Thus, psychology needs to investigate how this communication should be modulated in regard to the affective and cognitive processes of its audience. This latter should include both the general audience and the policy makers. Though, for the scope of my project, I focused only on the first one. Indeed, even though people may tend to believe that climate change is unwavering and that we cannot do much about it if the big companies (e.g., oil corporations) don't stop their businesses, it is widely acknowledged by the scientific community that individual behavior can make the difference (Swim et al., 2011; Wynes & Nicholas, 2017). Many environmental issues that society is facing, such as ecosystem collapse, demand considerable public investment to reverse. However, this investment will only arise if it is supported by the general community (Curtis et al., 2012), and common ecological behaviors is a positive cueing for each individual, leading to environmentally friendly choices (Cornelissen et al., 2008). Thus, individual behavior is crucial, but the climate change communication faces many challenges in respect to people's affective and cognitive approach to this topic. The Center for Research on Environmental Decisions (CRED) of Columbia University has worked on a guide that synthesizes these kinds of problems (Shome & Marx, 2009).

First, people's mental model (i.e., a person's understanding of the surrounding world) on climate change can differ largely, due to their nature of intuitive conceptions based of previous experience and the often partial and incomplete information underpinning it (Carey, 1986), which in turn, creates a meaning that shapes and guides our actions and behavior (Morgan, 2002), making people selecting and absorbing prevalently those information that matches and confirm the most their fixed beliefs (i.e., confirmation bias). Moreover, people may have different tendency of approach in relation to threats, such as, for instance, in terms of gains and losses (Cesario et al., 2004), and they typically perceive immediate threats as more relevant and of greater urgency than future problems (Slovic, 2000). Finally, people need to feel that the emergency touches them personally, that is not far from their interest and life. All these elements, thus, need to be considered and modulated accordingly when communication deals with environmental issues if the aim is to have an influence on people's thoughts and behavior.

One way to deal with these problems is to frame an issue within an appropriate context, so to achieve the desired interpretation or perspective (i.e., making it credible and/or accessible to the public). Some scholars suggest that climate change framing should take advantage of

some consistent human cognitive characteristics (Shome & Marx, 2009), and hence focus on the present rather than the future (Lorenzoni et al., 2006; Laiserowitz, 2007), show salience, relevance, authority and legitimacy (Cash et al., 2002), and emphasize losses (Kahneman & Tversky, 1979; Thaler, 1981). These assumptions are, indeed, related to the fact that human minds are not designed to immediately react to threats that seem to manifest themselves in the distant future (like climate change) as they do for immediate risks (Chaiken & Trope, 1999; Marx et al., 2007; Sloman, 1996; Weber, 2006; Epstein, 1994). Further, we also have a natural tendency to avoid losses rather than to seek gains, and to discount future gains more than future losses (Tversky & Kahneman, 1992; Kahneman et al., 1991; Higgins, 1997; 2000).

These and other assumptions belonging to the research in cognitive science, are often adopted in behavioral economics to propose theories and models concerning ways to influence people's decision-making processes according to our heuristics and biases. In the last two decades a large amount of work has been done on nudging, including green nudging (i.e., in relation to environmental protection).

4.3. Green nudging: theoretical bases, applications, critics, and limitations

A nudge is considered “any aspect of the choice architecture that alters the behavior of individuals in a predictable way, without prohibiting any options or significantly altering economic incentives” (Thaler & Sustain, 2008, p.19). The idea is based on the concept that human beings, far from being perfectly rational agents, can be unpredictable and error-prone even when it concerns their personal advantage (Kahneman, 2012), in opposition with the classical economic thinking that has its roots in Adam Smith's rational choice theory (Boudon, 2003) and developed across the century from Bernoulli's theories of utility (Bernoulli, 1954) to the expected utility theory reformulated by Von Neumann and Morgenstern (1953). Indeed, the belief in man's ability to make rational choices has underpinned economic analyses of policies (fiscal, monetary, health and environmental) right up to the present day (Grune-Yanoff, 2007). Though, Herbert Simon (1955) had already theorized the ‘bounded’ or ‘approximate’ rationality of human beings, i.e. the fact that the human ability to make rational decisions is subject to fundamental limitations, among which there are: availability of information, the time frame in which choices must be made, and internal cognitive constraints (Simon, 1990). Further, we know that our decisions may also be significantly conditioned by the context in which they take place (Gigerenzer, 2015).

The definition of nudging, as defined by their originators, contains two implicit assumptions: first, it concerns a tool capable of changing people's behavior, and this possibility stems precisely from the internal cognitive limits common to all human beings (Shubert et al., 2018; 2019; 2021), such to be defined as “the exploitation of bounded human rationality” (Evans et al., 2017, p.7). Second, human rationality is not only *bounded*, but also predictable, and therefore manipulable, and this predictable irrationality (Moratti, 2020) is due to the heuristics we rely on when we make choices, which become biases when systematically repeated. Hence, the overall concept of nudging has its roots on the dual process theory (Evans, 2008), which in turn has its ancestors in the dual mode of thinking (associative and reasoning) of William James, and the heuristic and analytic processes of Wason and Evans (1974). Kahneman (2003) described these processes as intuition and reasoning, belonging to two different systems: System 1 is an intuitive, automatic, involuntary, fast and impulsive process, while System 2 is a more reflective, reasoned, deliberative and planned process. The two systems communicate and interact with each other, with System 2 acting as a kind of control filter, ultimately translating some thoughts (rather than others) into behavior (Kahneman, 2012). Similarly, the elaboration likelihood model of persuasion (Petty & Cacioppo, 1986) depicts *central* and *peripheral* as two decision making and persuasion routes, in which the central route occurs via conscious and logical thinking when people are paying attention, whereas the peripheral route is taken when audiences are swayed by the superficialities of the situation. Therefore, what nudging does, is to exploit our System1-related heuristics and biases, influencing the automatic level of cognition in respect to decision-making processes (Hansen, 2016), but at the same time, given the interaction between the two systems, it can also influence more deliberative thought processes (Hansen & Jespersen 2013; Schubert, 2016; Sunstein, 2014).

Theories about nudging cross with the overall arguments of the present thesis since some researchers see them as a fruitful way to intercede with people's behavior in relation to the protection of the environment, i.e., a way to “gently guide” them towards sustainable choices (Evans et al., 2017). Indeed, in regard to climate change, some researchers claim that rational deliberation is often overridden by common biases and judgements based on emotions and associations (Zaval and Cornwell, 2016), such that the audience levels of endorsement of the scientific inquiry (linked to System1 judgements and the peripheral route) could be a better predictor of support for pro-environmental policies than the levels of scientific literacy (i.e., the scientific knowledge each one possess about climate change) (Drummond et al., 2016).

They assert that decisions are impacted by affective routes equal to or more than analytic processes, and that this applies to judgments about climate change (Weber & Stern, 2011), but at the same time, despite evidence that the intuitive processing system can be a strong motivator for action, most climate change communication remains geared towards the analytical processing system (Shome & Marx, 2009).

A wide variety of nudges have been experimented in relations to pro-environmental choices (i.e., green nudging), which may be divide into four broad categories (Nielsen et al., 2017): the simple provision of information, the modification of default options, the modification of the physical environment, and the use of social norms (for a brief description of these macro-categories with respective examples see Moratti, 2020). One of the most famous cases, for instance, concerned an intervention on the architecture of choice such as the reduction of the size of plates used in canteens to counteract food waste (Wansink, 2004; Kallbekken & Saelen, 2013). All categories are somehow related to framing, which, as mentioned, is crucial for climate change communication efficacy. Framing is a way to play and interact with our perception (and consequentially our decisions) according to our heuristics and biases (Ölander & Thøgersen, 2014; Tversky & Kahneman, 1974), i.e., our “mental shortcuts” through which we find adequate and easy (though often imperfect) answers to difficult problems (Michalek et al., 2015; Kahneman (2012). Indeed, climate change communication has to deal with some of the most common cognitive bias such as the present bias (i.e., the above already mentioned human propensity to discount gains and losses that we foresee in the future), the confirmation bias (i.e., deliberate search for confirming evidence, see for instance Weber & Stern, 2011) and the overthinking bias (cognitive overload that leads to mental strain and subsequently indifference or preference inconsistency for decisions, see for instance Lee, Amir & Ariely, 2009). Additionally, in most cases environmental issues have the particular spatial-temporal characteristic of encompassing a complex range of events in which the detrimental effects of human conduct are not immediately recognizable, and are also inequitably distributed (Mickwitz, 2003). This makes the cause-and-effect dynamics intangible and less obvious or identifiable (Lazarus, 2014), thus increasing the difficulty to encourage people in adopting pro-environmental lifestyles. These problems often lead to the so-called attitude-behavior gap (or also referred to as the intention-action gap: Allcott & Mullainathan, 2010; Momsen & Stoerk, 2014). In a study by Codagnone et al. (2016), for instance, between 70% and 80% of respondents declared themselves to be informed and in favor of sustainable consumption, but only a small minority (3%-5%) subscribe to contracts for energy supplies

from renewable sources or buy products with a lower environmental impact. Hence, sustainability is an area that often escapes the traditional interventions adopted by economic policy, and it is for this reason that some consider nudging as a very effective tool for environmental purposes (Dolan et al., 2010). The default option nudge (i.e., in a decisional context, the strategy to put the more sustainable option as the default one, so to avoid the effort of choice), for example, is a way to exploit several human distortions, such as the status quo bias, the anchoring heuristic, loss aversion, cognitive ease bias, and implicit recommendation, which all implies that one perceives default options as being superior or endorsed (Kahneman & Tversky, 1984; Michalek et al., 2015).

Nevertheless, nudging is not exempt from criticism, among which there are especially: an underestimation of the human being's rational-deliberative capacity to assess the best choices for oneself (Lepenies & Malecka, 2015), a limitation of people's autonomy (and thus of individual right), and its use by politics, since a tool like this, if in the wrong hands, can lead to nefarious outcomes (Gigerenzer, 2015). According to these criticisms, Thaler and Sustain defended their theory of nudging claiming that it must never prohibit freedom of choice or significantly altering economic incentives (Thaler & Sustein, 2008). For the authors, in fact, it is crucial that nudging strategies still preserve the decision-maker's free will: "To be considered a mere nudge, the intervention must be able to be avoided easily and without excessive cost" (Ibid., p.19). In addition, they state that their concept of nudging ties in with what they described as *libertarian paternalism*:

libertarian paternalists argue that individuals should be 'free to choose'. Our goal is to formulate policy measures that protect or increase freedom of choice. The adjective libertarian, used as an attribute to paternalism, simply means 'preserving freedom'. [...] We see ourselves as paternalistic in that we believe that it is permissible for architects of choice to seek to influence the behaviour of individuals in order to make their lives longer, healthier, and better. (Ibid., p. 18)

To discuss the ambiguity that the use of a strong term such as paternalism may entail, it would be beyond the goal of the present work. However, what is important to note is that, even if the intent would be to guide people towards the best choice for them and for society, the concept of libertarian paternalism implies that, because of our heuristics and biases, individuals cannot recognize themselves what is best for their own interest (Sunstein, 2014). This assumption brings to two crucial weaknesses of nudging, especially in relation to sustainability and environmental policies: a) it does not lead to a real conscious change in people's behavior; b) the alleged precariousness of its strategies. Indeed, since it relies mostly

on System 1 distortions and biases, many scholars see nudging applied to policy as a government driving on autopilot, i.e., a system in which neither the drivers (politicians) nor the passengers (citizens) learn anything, thus, as the autopilot (the nudge) disappears, its effects also fade out (Evans et al., 2017). Effectively, this criticism is linked to the fact that, to date, there is still little evidence that the behavioral changes induced by nudging can last (Raihani, 2013), especially for those types of nudging that impact merely at the level of automatic and habitual cognitive processes, and which may lose effectiveness over time (Michalek et al., 2015). Perhaps, the limitation of paternalism consists precisely in this, as Hansen & Jespersen (2013) suggest: “while nudging is a means to promote behavioral change, libertarian paternalism is a guide, or a series of constraints on what ends may be promoted” (p. 12).

In conclusion, the advantage of using the default effect should not be seen as a real solution, as well for the strategies that aim at influencing our behavior through our System1 instinctive reactions. This assumption can be evidently linked to the role of emotions previously discussed in this thesis, i.e., their being anticipators of interactions and thus influencers of our decisions and actions. It is true, indeed, that in a decision-making context in which a choice needs to be made, our judgments may be based on the emotions attached to the respective alternatives, thus following an affective heuristic (Finucane et al., 2000). Perceived emotions associated with a given choice serve as a substitute for cost-benefit or quantitative analysis, and they prompt a situation in which the person’s “likes or dislikes determine their beliefs about the world” (Kahneman, 2012, p. 103). A high degree of positively valenced emotion may lead, for instance, to a higher willingness to pay (Kahneman, 2012). Yet, although an emotional appeal may increase an audience’s interest in climate change in the short run, it may backfire down the road, producing negative consequences that often proved to be quite difficult to reverse (Shome & Marx, 2009). For instance, human beings seem to generally have a limited capacity for worrying about issues, something that scholars refer to as a finite pool of worry (Linville & Fisher, 1991), that is, a limited capacity for issues we can worry about at once. Hence, although the emotional system may work in the short term, it will be hard for people to retain that level of emotional intensity toward a specific environmental issue, and their attention will easily shift to other issues, unless they are given additional reasons to remain engaged (Weber, 2006). Further, these studies show also that the effects of worry can lead to emotional numbing, namely, an emotionally draining situation due to repeated exposures. Finally, reactions based on emotional threat may elicit the single action bias, which lead people

to employ only one response, even when it doesn't represent the most effective option (Weber, 1997; Hansen et al., 2004).

4.4. Beauty as a nudge?

Therefore, can beauty and positive affect be a nudge for pro-environmental behaviors? Although the existence of an instinctive and automatic reaction to beauty could give reason to hypothesize an effect of System 1, and in turn, on our spontaneous decisions, green nudging to be really efficient should prompt pro-environmental behaviors triggered not only by the physical context (e.g., the sustainable object's characteristics and the consequential aesthetic pleasantness), but rather induce a real change in people's awareness and lifestyles, modulating these latter according to the target of the intervention. Thus, in terms of the dual process theory, the crucial point would be that the two systems underlying the mechanisms of our decision-making processes (System 1 and 2) must work together and interact with each other. Indeed, the problem of nudging's lack of longevity seems to lie in the fact that its strategies often fail to involve System 2: the evaluative-analytical process requires a cognitive commitment that nudges tend instead to *save* (Moratti, 2020). Effective and lasting nudging, therefore, should intervene not only at the level of the more intuitive and immediate cognitive processes, but also favor analysis and internalization of the choice, so that the behavior does not fade with the fading of the nudge. Finally, this should depend, in turn, on how and if positive emotions as the pleasure of beauty may be able and strong enough to interact with motivations and expectations (and with individual differences such as previous knowledge-experience), so to induce a cognitive reflection as deep that it may allow to influence our decisions and act for real transformation (vedi Pelowski et al., 2017, Pizzolante et al., 2024; Leder & Pelowski, 2023).

About this latter mechanism described, many scholars support the idea that art may be able to do induce it, and this is precisely the ultimate function of environmental art in respect to climate change. Therefore, in the next section, I will introduce an overview about this specific type of art and its peculiarities in relations to cognitive, affective, and behavioral processes.

4.5. Environmental Art

Environmental art concerns any kind of artwork that aims to prompt discussion and/or action around environmental issues (Marks et al., 2016; Roosen et al., 2018). Thus, it is about the artists' intention rather than the materials used, the format, or the place in which it is presented (Marks, 2015). The key difference for this type of art in respect to others is indeed the intent to express and/or foster pro-environmental awareness and behaviors. Pro-environmental behavior (PEB) is any behavior that is performed with the intention to benefit the environment (Lange and Dewitte, 2019; Li et al., 2019; Steg et al., 2014; Osbaldiston & Schott 2012; Stern, 2000)⁶.

Environmental art has manifested since the 1960s in many formats and interchangeably definitions such as land art, earth art, or (more recently) climate art. It can be created in any kind of context, from nature to galleries (Spaid, 2002), and it can involve processes as well as objects, from recycled materials to multi-media performances (Weintraub, 2012). Much of the environmental art literature is written from an art historical perspective and focuses on the early period of the 1960s and 1970s, when earthworks or land art emerged as a contemporary art movement (Matilsky, 1992; Prigann, 2004; Tiberghien, 1995). Within the societal change of those years, artists began negotiating ways in which they could contribute solutions to environmental problems, encouraging the relationship between art and science (Prigann, 2004), with several artists developing approaches to engage people's consciences and raise their environmental awareness (Song, 2009). Most recently, some environmental artists have utilized digital technologies as a medium to encourage pro-environmental behavior and engage with a wider audience. Eco-visualizations, for instance, is a way of interpreting environmental data as imagery rather than numerically (Holmes, 2011).

From a psychological perspective, analysis and reviews of studies about environmental art (Roosen et al., 2018; Curtis et al., 2014) have led to the assertion that it can help audiences to visualize climate issues and find solutions in unique ways, affecting pro-environmental behaviors, values, attitudes, awareness, habits, norms and initiatives. This may happen through a range of effects such as a strong emotional response in respect to a specific issue, high levels of attention and reflection, and a particular personal connection with the topic. Furthermore, in relation to the affective heuristic previously discussed, some scholars attribute to

⁶ In the present thesis I'm using also "sustainable behavior" attributing it the same meaning. Hence, the two expressions need to be considered interchangeable.

environmental art the unique capacity to convey cultural meaning through emotional and experiential engagement, thus leveraging more emotion-based biases which overcomes motivated reasoning (Corbet & Clark, 2017; Galafassi et al., 2018; Nurmis, 2016; van der Linden et al., 2015), and stimulate attitudes and behavioral change in audiences (Duxbury, 2010; Hollo & Rimmer, 2014).

Nevertheless, research on its effects is still limited, and there is no agreement on how this impact occurs (Curtis et al., 2014; Klöckner, 2015; Galafassi et al., 2018; Moser, 2016). Apparently, most efficient outcomes have been found in projects incorporating practice-based learning, that is, learning through experience and practice, which is said to encourage pro-environmental behavior more effectively than mere informational programs (De Young 1993; Heimlich & Ardoin, 2008; Jackson, 2005). Indeed, treating the issue in smaller informal groups affiliated to a specific subculture or a local community seems to bring often positive effects (Krantz, 2006; 2008; Marx et al., 2007; Roncoli, 2006; Jackson, 2008; Brewer & Kramer, 1986). Participatory environmental art projects seem to confirm this by encouraging collaboration between members, social learning, sharing of environmental knowledge and skills, and sense of belonging, resulting in a strong place attachment or identity that brings to maintain their communal areas and create more aesthetically pleasing built and natural environments (Vaske & Kobrin 2001; Young 1999). Curtis (2003; 2006; 2009; 2010), for instance, created a community production that brought together 170 performers, including collaborations from a number of community arts groups, to present an environmentally-inspired performance in a cattle yard in rural Armidale (Australia), and claimed that art “affected environmental behavior by increasing emotional affinity towards nature, generating a cognitive interest in nature, and provoking emotional indignation about insufficient nature protection” (Curtis, 2009, p. 182).

4.6. Attitudes and emotions in respect to sustainability

These considerations brought some researchers to claim that, contrary to those who assign the reason of limited engagement to a lack of scientific literacy (Hart & Nisbet, 2012; Kahan et al., 2012; Leiserowitz et al., 2010), people beliefs are often attached to their social and political positions, which make them disregarding the need for collective interference in decision making or individual wellbeing (Kahan et al., 2015; Kahan et al., 2012). On one hand, as it was already largely discussed, it is probably undeniable that scientific facts are searched,

remembered, and assimilated through a match with pre-existing worldviews about both policy and environment (Hornsey et al., 2016). These beliefs and values are what constitutes attitudes (Schultz et al., 2005; Kassin et al., 2015; Steg & Groot, 2012), which in turn, are said to be theoretically reliable and valid influence of daily decision making and for the predictability of environmentally sustainable behaviors (Schultz & Zelezny, 1999; Steg & Vlek, 2009; Thomas & Walker, 2016).

Attitudes consist of emotions and feelings as well as beliefs and judgements (Breckler & Wiggins, 1989), hence, affective and cognitive components. Indeed, affect, emotions, and personal experience may influence risk perceptions and support for policies related to climate change (Leiserowitz, 2006; Slovic et al., 2007). It has been shown, for instance, that aesthetic emotions can increase readiness to ascribe intentions, beliefs, and emotions to others (Kidd & Castano 2013), or that they can prompt engaging in prosocial behavior (Fukui & Toyoshima 2014, Pessiglione & Lebreton, 2015). Furthermore, some researchers suggest that an individual's affect can be a crucial component in risk evaluation, ethical and moral decision making, as well as attitude formation and judgment, and that it can interact with their reason in order to directly influence how they respond to and process information (Bodur et al., 2000; Slovic, Finucane, Peters, & MacGregor, 2007). As already discussed, aesthetic emotions can provide the agent with the motivation to enact by assigning values and meanings to specific interaction, experiences to which we ascribe pleasurable and significant learning (e.g., Xenakis & Arnellos, 2015). It follows that a positive feeling as say beauty, together with the cognitive reflection that it may bring towards an artwork, may play a key role in influencing "world-focused modes of action readiness" (Scarantino, 2022), i.e., actual behavioral change. Though, as anticipated above, the relation between affect and behavior is not so straightforward, since other components need to be taken into account (e.g., individual differences).

In addition, there is no agreement yet on whether positive or negative emotions are more effective. Indeed, the use of positive emotions has mixed responses. Hope, for instance, it is said to increase action in some studies (Moser, 2015; Moser, 2016), though others claim that it lowers risk perception and thus leads to a decrease of action (e.g., Hornsey et al., 2016). Positive affect can be mediated by environmental concern (Coelho et al., 2017), and some emotions like happiness and calmness can be inversely correlated with motivations to act (Beattie et al., 2011). Studies on negative affect, in turn, show also contrasting results. Some findings suggest that it can be positively related to support of climate change policies and self-reported pro-environmental behaviors (Leviston & Walker, 2013; Wang et al., 2018), though,

a strong negative emotional response can terminate further thoughts on the topic due to a desire to avoid the associated distress (Slovic et al., 2007). Findings regarding single emotions also are mixed: in regard to guilt and fear, for instance, some show that they can contribute to pro-environmental intentions and behaviors (Harth et al., 2013; Rees et al., 2015), whereas others show that it can result in feelings of being overwhelmed and disengaged (O'Neill & Nicholson-Cole, 2009), thus leading some scholars to the conclusion that fear-based arguments are not effective tools for action (Reser & Bradley, 2017). Consequently, an individual's emotional reaction to climate change information may be difficult to predict with certainty, and thus, it is not easy to develop an effective communication strategy (Moser & Dilling, 2007; Roeser, 2012).

4.7. A model for environmental art

The problem just described evidently pertains also to environmental art. A way through which researchers have been testing the effect of this type of art is by exploring audiences' responses to environmental art festivals (Marks et al., 2016; Sommer & Klockner, 2021; Sommer et al., 2029; Klockner & Sommer, 2021). In relation to this kind of investigation, Klockner and Sommer (2021) proposed and tested a psychological model of environmental art perception and subsequent support for climate change policies. The model assumes that our response to the artwork is first an emotional reaction (positive and/or negative) which leads to an evaluation of it, in which the perceived quality of the artwork can play a key role. This view is in line with other main theories that ascribe the effectiveness of climate art in changing attitudes and behavior to the influence and strength of the affective engagement (Curtis et al., 2014; Marks et al., 2016).

Basically, according to the outcome of this first impression, the artwork would trigger or not cognitive reflections that may, in turn, result in support for climate policies. Klockner and Sommer (2021) tested the model at ArtCOP21 that was held during the 21st UN climate summit in Paris, collecting data from 883 participants. Their findings show that both positive and negative emotional reactions may relate significantly to the mediating cognitive variables they used, namely, perceived quality and reflections on the artwork. Specifically, positive emotions were more related to the perceived quality, whereas negative emotions were related to the reflection on the artworks. The stronger the emotional involvement (either positive or negative), and the higher was the perceived quality and the reflections on the artwork. Then,

the deeper the reflection on the artwork was, the more support for climate policy was reported. Interestingly, the relation between reflections on the artwork and support for climate policies was found stronger for people with weaker environmental attitudes than for people with stronger attitudes. Furthermore, they investigated if the first impression of the artworks and the related reflections elicited could be associated with specific features like color, size, or personal reference of the content. They found that positive emotions were positively correlated with colorful artworks, with the presence of information, and the displaying of something personal to identify with. On the other hand, they were negatively correlated with size, familiarity with the object, pick shift principle, and catastrophic imagery. Negative emotions, in turn, were positively related to the size (the bigger the artwork was, the higher the negative emotion elicited) and to the triggering of perceptual problem solving.

All in all, this study represents a good overview to introduce most of the crucial aspects that need to be considered for this kind of research (some of them are discussed again in detail in Study 3 – “Aesthetic Experience and Environmental Art, Chapter VII).

4.8. About crucial aspects of the environmental art research: theoretical premises for Study 3 and 5

The fact that artworks may prompt moments of reflection that are related to meaning-making is an assumption consistent throughout several models of aesthetic experience (see Pelowski et al., 2016 for a review). More precisely, though, some of the most acclaimed models suggest indeed the existence of a continuously interactive process between cognitive and affective mechanisms-responses (e.g., Leder et al., 2004; Leder & Nadal, 2014, Pelowski et al., 2017), whereas in the model just described (Klockner & Sommer, 2021) the emotional reaction comes first, as other models that we already mentioned (e.g., Locher et al., 2010). As has been previously argued in this thesis, it is unquestionable that it all starts with a first impression and that its affective valence and arousal can in fact anticipate (and be crucial for) the prosecution of the interaction and the ascription of an impactful meaning. Though, as shown by the above-mentioned models, emotions and the overall affective response may overlap with the cognitive pathways all along the experience in a non-stop feedback loop which, depending on several different factors, it may bring eventually to a significant and transformative experience. These factors can indeed be related either to specific features of the artworks or to individual characteristics. The study of Klockner and Sommer measured some of the formers (color and

size) and some of the latter (personal identification, perceived quality, and attitude). Evidently, there are many features that can be added, and each experimental design needs to choose which one could be the best to investigate in accordance with the types of stimuli and the specific aims and questions of the research. As it will be shown, Study 3 – “Aesthetic Experience and Environmental Art” (Chapter VII) focuses on affective and cognitive responses, specifically in terms of beauty and emotions (positive and negative) for the formers, and meaningfulness and cognitive reflection for the latters, evaluated either for each stimulus or for the whole experience. We did not check for correlations with specific physical features of the artworks, since we used similar works of just two specific artists whose creations are plastic-waste installations (rather than very different kinds and styles of artwork as in Klockner and Sommer study). In relation to the overall theoretical frames that have been discussed in this chapter, there are two specific elements to be importantly remarked in relation to a possible influence on our intentions and behavior: emotions and motivations (and of course their interaction).

In regard to emotions, in Klockner and Sommer’s study the negative correlation of positive emotions with familiarity of the content and peak shift principle can be interpreted in light of what has been argued so far about the effect and importance of novelty, and the fact that the higher pleasure of an interaction comes from the solving of something unexpected (and the subsequent learning) which, though, it induces first a negative reaction due to its initial challenge. Indeed, this seems further confirmed with the correlation between negative emotions and triggering of perceptual problem-solving. Finally, in a parallel paper about the same study where responses to the different ways of depicting environmental problems were compared (e.g., encouraging positive solutions Vs discouraging future scenarios), the authors finally concluded that:

activist art, including environmental art, should move away from a dystopian way of depicting the problems of climate change, towards offering solutions and emphasizing the beauty and interconnectedness of nature. Dystopian elements to initially catch attention, but remaining solution focused, and hopeful may be even more promising in encouraging action. (Sommer & Klockner, 2021, p. 24).

Indeed, they are not the only ones claiming this view. Some researchers argue that catastrophic framing may be blocking more sustainable political pathways, as well as deeper societal engagement with environmental issues, and they propose alternative frames that adopt an ethical or historical perspective (Hulme, 2009). Some studies, for instance, examined the

effect of fear-inducing imagery and icons on climate change engagement, showing that catastrophic framing is likely to disempower individuals, distancing them from the issue and leading to feelings of fatalism, denial, or apathy (O'Neill and Nicholson-Cole, 2009), and reducing motivation (O'Neill et al., 2010). Nevertheless, findings on which kind of frames may be more effective are contradictory, and the debate is far from an ultimate solution. Studies that have been done on the effects of videos, for instance, reported contrasting results: some show that positively framed environmental videos are more effective than negatively framed ones to induce pro-environmental behavior (Jacobson et al., 2019; Shreedhar & Mourato, 2019), while other showed the opposite (Schwartz & Loewenstein, 2017; Shen et al., 2020), or no difference between the two (Franzen & Mader, 2020; for more info see Diessner et al., 2022).

Similarly, theories and findings on the relation between the effect of art (being images, documentaries, or exhibitions) on sustainable behavior and individual traits-characteristics (e.g., attitude) show divergent findings and corroborate different conclusions. In Zelenski et al. (2015), for instance, exposure to target videos (nature documentaries) increased pro-environmental donation behavior but only in those already having a strong sense of connectedness with nature. Klockner & Sommer (2021), instead, found that support for climate policies (related to reflection on the artwork) was higher for people with weaker environmental attitudes rather than stronger attitudes. Nevertheless, it should be also considered (and the authors indeed admitted it in the limitations of their study) that their sample had an overall strong interest and attitude toward environmental problems, and they considered themselves as art interested.

All in all, the study by Klockner & Sommer depicts a picture of several possible mechanisms and outcomes in reaction to environmental art. Evidently, their study shows that art exhibition on climate change can bring people closer to a topic unfortunately too often felt as distant from their everyday experience (Lorenzoni et al., 2007; Moser, 2016), creating a space of interaction between art and science where the viewer-spectator can find space to create a meaning of the message which resonate with his or her own life (Gabrys & Yusoff, 2012).

In this regard, Study 3 (Chapter VII) represents an examination of aesthetic experience and Environmental Art through which we investigated the role of cognitive and affective mechanism related to a specific type of communication, on a precise environmental issue, using a widespread medium (i.e., digital images), and for a very general kind of audience. That is, we used images of plastic-waste artistic installation made within nature, i.e., with the aim of

exalting the contrast between nature and the effect of human behavior, thus, in relation to the plastic waste issue. The artworks we used could be interpreted as having negative framing of the problem, since the artistic compositions of plastics were made in contrast with the beauty of the natural environment. This was not done because of a theoretical choice, but to test existing examples of this type of art made by very well-known artists, as well as to provide insights into this specific choice of producing (and thus experiencing) this art, i.e., a real possible context in which this type of art may be presented. Indeed, people often encounter this art at home, on their computer or phones, through some online magazines or shared on social media, so their experience with these artworks is mostly through digital images on a screen, rather than in a gallery or in the actual space where the installation is made. Hence, this is precisely the type of scenario we investigated in our laboratory study. Moreover, this investigation was done to look for any influence on pro-environmental intentions and donations⁷ on a sample of people who had little concern about the ecological world-issues, and that were not interested in art at all. Although this type of audience probably represents the hardest challenge to face for environmental art, at the same time, inducing an impactful change on the general public should be considered as its ultimate goal.

Finally, artworks shown in Study 3 did not include any descriptions since we didn't want the cognitive reflection to be influenced by additional information, rather, we aimed at inducing cognitive reflection by repetitions and long exposures (see §7.4 for more details). Some studies show that contextualizing the artwork, although it can increase personal meaning, it does not necessarily translate into a change in intentions or behavior in favor of the environment (Keller et al., 2020). Hence, without the addition of any specific description, we intended to test the discovery of the novelty-surprise mechanisms that had been largely discussed previously in this thesis, assuming that the understanding of something unexpected could accentuate the impact of the whole experience. However, Klockner and Sommer's study, for instance, shows that emotions can be positively increased by descriptive information about the artwork and the artist, a finding confirmed by many other studies (Darda & Chatterjee, 2023; Castellotti et al., 2023; Gerger & Leder, 2015; Mastandrea & Umiltà, 2016; Szubielska & Imbir, 2021; Swami, 2013). Indeed, the correlation between additional descriptive information and personal resonance of the content-meaning is in line with what has been said so far about the importance of each person's previous experience and the process of interpretation according to each one's personal knowledge. In Study 5 – “Aesthetic Experience

⁷ More info about these two variables will be given in detail within the report of Study 3 in Chapter VII.

and Descriptive Information in the Art of Re-purposing” (Chapter IX) we conducted a pilot experiment to explore the effects due to the addition of this linguistic component. Specifically, we tested this comparison (i.e., artworks presented with or without descriptive information) through the exposure to two different styles of artistic creations made with waste materials. Indeed, we tested the same stimuli used in Study 3 as well as different stimuli belonging to two other artists. These latter make framework-like artworks with little scrap materials, either reproducing famous masterpieces or creating original compositions. Hence, although they represent a different approach in respect to environmental art, both types of creations consist in an art of re-purposing through which the reuse of waste and scrap materials gives new life to these products, showing possible renovation against the devastating effect of overproductions and fast consumption.

All in all, given that there is still a long way to go in order to reach a solution, and further important developments will certainly be needed, I hope that this research may contribute to enlarging the understanding in function of such an important achievement for society as environmental sustainability.

PART II

EMPIRICAL STUDIES

CHAPTER V

STUDY 1

Aesthetic Experience and Affordance

The present empirical study⁸ is about everyday objects' affordances in relation to the change of material. To investigate this process, we adapted a paradigm that has been already used to study affordance modulation in relation to linguistical and physical context, i.e., language comprehension and object location (Ambrosini et al., 2012; Constantini et al., 2011). Thus, we implemented a design in which the material factor interplays with these other two components (language and space). Specifically, we focused on the difference between sustainable (wood) and non-sustainable (plastic) objects, considering that the change in the sustainability of the material may entail a shift of the objects' familiarity and aesthetic pleasantness as well, thus affecting their perception, evaluation, and vision-action coupling (i.e., affordances). We consider these processes as inevitably related to the perceiver's aesthetic preferences, leading us to link the investigation on affordances activation with the research in Empirical Aesthetics.

5.1. Introduction

When we interact with objects, they offer us various possibilities for interaction, namely, affordances. The concept of affordance (Gibson, 1979) is a central theoretical construct within environmental and ecological psychology, associated nowadays with a very large and varied literature (Osiurak et al., 2017). Particularly, it has been widely employed in studies on grounded and embodied cognition, since it shows that perception and action are strictly interrelated (Borghi, 2018; Chemero, 2003; Ellis & Tucker, 2000). Broader definitions of affordances have also been introduced, that link affordances to social and cultural practices

⁸ Naddei Grasso, E., Strappini, F., Borghi A., Scorolli, C.. (2024) "Affordances, aesthetics, and sustainability: on the relationship between materials, language, and space in everyday object perception".

At present, this study is submitted to the journal *Current Research in Ecological and Social Psychology*. The following report represents a larger and more detailed version of the study, necessary for the purpose of the present thesis.

(e.g., Rietveld & Kiverstein, 2014). In sum, given its use in many different fields of study, the definition of affordances is inevitably more nuanced since Gibson's (1979) definition and dependent on the perspective of reference (Chong & Proctor, 2020).

Many researchers have studied affordances in relation to the design of common objects which have properties that afford actions associated with their canonical use (e.g., Tucker & Ellis, 2004). A substantial literature shows how affordance activation may be modulated by many factors, such as the manipulable aspects of the object (Ellis & Tucker, 2000; Bub & Masson, 2010); the spatial relation between the object and the agent (Cardellicchio et al., 2011; Costantini et al., 2011a; Costantini et al., 2010; Ferri et al., 2011; Yang & Beilock, 2011); the parallel linguistic elaboration (Ambrosini et al., 2012; Bub et al., 2018); the social request of a specific context (Scorolli et al. 2014; Giannelli et al., 2013); the social norms (Scorolli et al., 2017; Constable et al., 2016; Constable et al., 2014); and the affective dimension (Caravà & Scorolli, 2020). Though, most empirical work in cognitive science has focused on the shape and size of objects, sometimes neglecting the analysis of other visual properties. A few studies have highlighted that there is a close link between color and shape (e.g., Garofalo and Riggio, 2022), or that the object's consistency can play a significant role (Anelli et al., 2010).

Here, we intended to study whether and how our readiness for action toward everyday objects is modulated by the change of materials. Differences in grasping have been found in relation to the material (Paulun et al., 2016) and the surface properties (Ingvarsdóttir & Balkenius, 2020). In terms of visual object imagery, recognition of materials is a rapid and accurate process (Sharan et al., 2009), even if slower than object recognition (Wiebel et al., 2013). Design studies showed that materials' potentials and modulations can be crucial for new possibilities of interaction to emerge (Barati & Karana, 2019; Overbeeke & Wensveen, 2003). This evidence highlights also the functionality of aesthetics, which can convey the action possibility offered by an artifact (Xenakis & Arnellos, 2013). Moreover, the material of which the objects are made, involving textures, colors, and shapes, represents a component which inevitably affects its aesthetic appreciation (Sauerwein et al., 2017). Thus, our investigation may certainly benefit from a link with the research that belongs to the field of Empirical Aesthetics.

5.1.1. Affordances and aesthetic experience

Affordances are not just objective properties offered by the environment, but they emerge as a consequence of the interaction between object, subject, and environment, therefore

modulated by dispositional properties of the individual (Turvey, 1992). This formulation implies that their activation is not only intrinsically linked to action and to the physical characteristics of the interaction, but also to the cognitive and evaluative aspects of the perceiver, who will thus be influenced by her/his prior knowledge and past experience (Cisek, 2007; Pezzullo & Cisek, 2016). In other words, affordances are not just about functional meanings and motor capabilities but also about emotional and cognitive processes that emerge through interaction (Kiverstein & Artese, 2023).

Put in these terms, the concept of affordance shares similar underpinnings that the field of Empirical Aesthetics usually associates to the concept of aesthetic experience, namely, an emergent state arising from interactions between sensory–motor, emotion–valuation, and meaning–knowledge neural systems (Chatterjee & Vartanian, 2014). Indeed, an aesthetic experience surely arises from a complex interplay of factors related to the object, the individual, and the context (Jacobsen, 2006). As Shusterman (1997) points out, this sort of interaction has three core components: an evaluative dimension (because it involves the valuation of an object), a phenomenological or affective dimension (because it is subjectively felt, drawing one's attention), and a semantic dimension (because it is also a meaningful experience, not just a mere sensation). As for affordances, the aesthetic experience is not just about meanings, but it involves both the cognitive and the affective systems, two dynamically interconnected but distinct processes (Leder et al., 2004; Leder & Nadal, 2014). Notably, this scientific field considers aesthetics in a wider sense than just a phenomenon that is exclusively related to the enjoyment of art: in line with the pragmatist theory (Dewey, 1980/1934), empirical aesthetics takes into account that both, our daily practices and our tastes, are nowadays shaped mostly through the relationship with the tools of everyday life, rather than with art (Matteucci, 2015), thus making our preferences modulated by everyday aesthetics (Saito, 2023). Therefore, when investigating affordances by everyday object, aesthetic preferences can be crucial. Aesthetic pleasantness may influence brain activity, specifically by facilitating tuning by tools perceived as highly affording but also highly attractive (Righi et al., 2014). Indeed, the aesthetic value and attractiveness of an object can determine one's behavior toward it, modulating our attention through cognitive and emotional processing (Pierguidi et al., 2016), and thus shortening our response times to the stimuli (Righi et al., 2017; Reppa & McDougall, 2022). Nevertheless, our aesthetic response can be different in relation to specific proprieties of an object. Although our judgments in respect to objects can share some preferences according to certain aesthetic proprieties such as, for instance, shape, dimension, novelty, or complexity (Berlyne, 1970, 1971; Carbon & Leder, 2005; Leder & Carbon, 2005), there are other distinctive aesthetic

qualities that are object-specific (Stich et al., 2007). Hence, in the present study we aimed to test whether the difference created by the change of material may influence affordance activation, investigating the material element in relation to our preferences and to the salience associated with, and enhanced by, the visual distinction of it. To do so, we planned to make this modulation in relation to a highly topical issue, especially amongst younger people: sustainability (e.g., Yamane & Kaneko, 2021). Sustainability may have several definitions (Moore et al., 2017); here, we use this term considering mainly the life-cycle assessment and the environmental impact of the material (Florez et al., 2013). A visual feature such as material may influence appraisals significantly in relation to a sustainable selection (Ljungberg, 2007). In turn, aesthetic appraisals can modulate motor affordances (Xenakis & Arnellos, 2013, Jensens & Pedersen, 2016). Thus, we intended to investigate whether this modulation occurs differently between sustainable and non-sustainable material.

5.1.2 The present study

For the selection of the type of materials to test, we relied on their social and environmental impact. Initially, objects made of plastic, wood, glass, and metal were considered. This attempt brought to the surface a specific difficulty related to the choice of changing the material component: different degrees of sustainability entail different degrees of the object's familiarity, the latter being a crucial element in influencing affordances' activation (Osiurak et al., 2017), as well as processing fluency (Reber et al., 2004). To avoid this confounding, our choice was then constrained to only two materials, namely, wood and plastic. Although there are currently very sustainable plastics, in common understanding plastic still represents the most polluting and disposal material (Oberoi & Garg, 2021), often contrasted with wood, the 'natural' material par excellence (Sands, 2022).

The modification of the material may induce different effects depending on (1) the context in which it takes place; (2) the familiarity and aesthetic-pleasantness of the object, as well as the observer's expectations of the type of action required; (3) the individuals' behavior in favor of the environment, which may affect responses to the stimuli. We explain below how we operationalized these three aspects in our investigation.

(1) For the same type of object, more or less polluting materials convey different messages (and thus suggest different actions), which are in turn modulated by the physical and linguistic context of our everyday life. In order to not ignore the effect/influence of these two socio-cultural aspects, we tested the same type of objects (i.e., very similar shape and dimension) made of plastic or wood, in near and far space (physical context), and in association

with verbs (linguistic context) that suggest either a general actions with the object (i.e., manipulation verbs: e.g., “to grab” referring to a cup), the final goal/use of the object (function verbs: e.g. “to drink” for a cup), actions to be done in collaboration with someone else (interaction verbs: e.g. “to pass”), or the simple viewing (observation verbs: e.g. “to watch”). These considerations helped us to choose the paradigm, opting for one already tested in previous studies in which the physical and linguistic context was specifically manipulated (Costantini et al., 2011a; Ambrosini et al., 2012). This paradigm used object-verb compatibility evaluation as a task: participants had to respond by releasing a button and mimic grasping.

Regarding the influence of the materials, we expected their effect to be modulated differently according to the contexts. Specifically, in the adopted behavioral paradigm, we expected reaction times to be faster in the case of objects made of plastic material because of their familiarity (Snodgrass & Vanderwart, 1980), since familiar stimuli are usually processed faster than novel stimuli (Reber et al., 2004; Haber & Hershenson, 1965; Jacoby & Dallas, 1981). Indeed, visual processes are more closely linked to haptic shape perception when objects are familiar, compared to when they are unfamiliar (Lacey et al., 2010), and the perception of plastics is embedded in social and cultural dimensions (Fisher, 2004). Furthermore, we should expect an advantage for objects in near space and for function verbs, in line with the other two studies that used this paradigm (Costantini et al., 2011a; Ambrosini et al., 2012). However, due to the change of material, the linguistic context should modulate this advantage in different ways. Hereafter, the predictions for the triple interaction (material/verbs/object location).

- Function and manipulation verbs should stress the actual use of the object. Thus, especially for those referring to a specific goal-action (verbs of function), we expect an advantage for plastic objects, with which we are more used to interact (evidently, that is the case for Italy: e.g.: Moschetti, 2023; Campanale et al., 2019).

- Observation verbs (e.g., to look, to observe) should make less dominant the object’s function, and more salient its beauty (i.e., aesthetic pleasantness), as they concern the mere contemplation of the object, and thus advantaging the most attractive ones, regardless of the object position.

- Interaction verbs (e.g., pass, offer, receive), which are new to our paradigm (in the previous ones they were not used), foresee the presence of another person, thus, they should increase the relevance of the far space, and possibly advantage objects made of wood (typically

more valuable: Ilker, 2016) rather than objects made of plastic (notably regarded as more disposable: Oberoi & Garg, 2021; Oberoi et al., 2021), regardless of the near or far location.

(2) When changing the material from which an object is made, important changes are necessarily brought about: **a.** on the expectations regarding the object's heaviness and hardness (and thus on the observer's type of visuomotor activation); **b.** on the number of experiences with similar objects that we can have as a reference, thus, on its familiarity; **c.** on the number of social interactions we have had with similar objects, the so-called sociality with objects (Cetina, 1997); **d.** on the pleasantness and desirability of that object. To check these aspects without further entangling the paradigm, we decided to administer ratings at the end of the experiment, asking participants to give an explicit judgement (on a 1-7 Likert scale) about these different aspects for each object tested in the study. Specifically, in respect to Desirability, we refer to the desire to possess the object (indeed, the question was “How much would you like to possess this object?”), whereas the object’s pleasantness (“How much do you like this object?”), we consider it equivalent to a judgement on the object’s beauty. Notably, aesthetic evaluations often overlap, so that ratings of pleasantness could be analogous to ratings of beauty or liking (Augustin et al., 2012; Jacobsen, 2006; Reber et al., 2004). Thus, in the context of this study, we consider the evaluation of the object’s pleasantness as an aesthetic assessment of beauty. With the term beauty, we are referring to a pleasurable subjective experience directed toward an object, which makes the concept of beauty interchangeable with that of aesthetic pleasure (Reber et al., 2004, p. 365). Even if pleasure and beauty are not strictly comparable, they can be considered equivalent in terms of their affective component when people appraise objects (Skov & Nadal, 2021). Indeed, considering that an object causes aesthetic pleasure for those who contemplate it as beautiful (Ducasse, 1944), aesthetic pleasantness can be associated with the personal judgment of beauty (McGreal, 1949). Therefore, since the rating question was “Do you like this object?”, entailing a personal evaluation, we here imply beauty as the aesthetic pleasantness appraisal related to the participants’ personal tastes. Finally, to these six ratings (i.e., Heaviness, Hardness, Familiarity, Sociality, Pleasantness, Desirability), we also checked **(e)** for an evaluation on the sustainability of the objects, in order to verify that the materials used (wood and plastic) were consistently rated as more and less sustainable. In relation to these features, we expected the following predictions.

a. Wooden objects would be evaluated as heavier and harder than plastic ones.

b. Plastic objects would be evaluated as more familiar by virtue of our extensive use of plastic.

- c. Plastic objects would suggest greater sociality by virtue of their greater use in social contexts.
 - d. Wooden objects would be rated as more pleasant and, consistently, more desirable than plastic objects by virtue of their association with valuable and durable objects.
 - e. Ratings on sustainability would confirm our manipulation of materials (i.e., wood-sustainable, plastic non-sustainable).
- (3) Finally, to assess the participants' degree of individual and social engagement in favor of the environment, and thus investigate whether it correlated with their responses, we administered a validated, self-reported scale on environmental behavior: the Pro-Environmental Behavior Scale (PEBS, Marke, 2013; Italian version by Menardo et al., 2020). Pro environmental behavior consists in a various set of altruistic actions related to environmental conservation such as energy of food consumption, and that consequently contributes to natural environmental sustainability (Lange and Dewitte, 2019; Li et al., 2019; Steg et al., 2014; Stern, 2000). Average values obtained on this scale would make the results of the participants comparable with each other, since responses could not be ascribable to significant different behavior in relation to the environment.

The investigation described in point (1), and specifically the interaction between the three variables (material, verbs and object location), represents the main focus of the study. The investigations defined under (2) and (3) are instrumental in refining the interpretation of our results.

5.2. Materials and Methods

5.2.1. Participants

We determined our sample size, all data exclusions, all manipulations, and all measures in the study, and we follow JARKS (Kazak, 2018). The sample size was based on the interaction between object position and verb reported in a previous study (Ambrosini et al., 2012). According to the study of reference, 29 participants were needed in order to detect a small effect size ($\eta^2_p = 0.13$) between these two factors, considering a power of 95% and a level of significance of 5% (two-sided, within-subjects *t*-test) (G*Power 3.1; Faul et al., 2007). We tested students who needed to participate in the experiment in order to receive credits. Finally, 50 students were tested for the study ($M_{age} = 25.46$, $SD = 5.96$; 64% females). They had normal or corrected-to-normal visual acuity and no self-reported history of attentional, psychiatric, or neurological disease. We employed only young right-handed subjects based on a self-report response.

Approval was obtained from the ethics committee of the Department of Philosophy and Communication of the University of Bologna. The procedures used in this study adhere to the tenets of the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study. The experiment reported here was performed using PsychoPy, version 2023.1.3 (Peirce et al., 2019).

5.2.2. Apparatus and materials

Participants were shown images of an object depicted on a table and positioned either near or far from the observer. Immediately after, a verb describing an action that could be compatible or not with that object appeared on the screen.

To create colored images (1728×1117 pixels), Adobe Photoshop was used. Objects consisted of six everyday kitchen tools: bottle, cup, plate, spoon, bowl, and small cup (the only object provided with a handle was the small cup: it was displayed always with the handle oriented towards the right side). In line with the main investigation of the study, objects were represented in two different surface materials: wood or plastic. In regard to the modulation of the physical context, the images presented the objects, with a proportioned scaled size, at two different Object Locations, near and far, respectively, closer to the observer or at the most distant edge of the table, for a total amount of 24 images ($6 \times 2 \times 2$), see Figure 1 and 2.

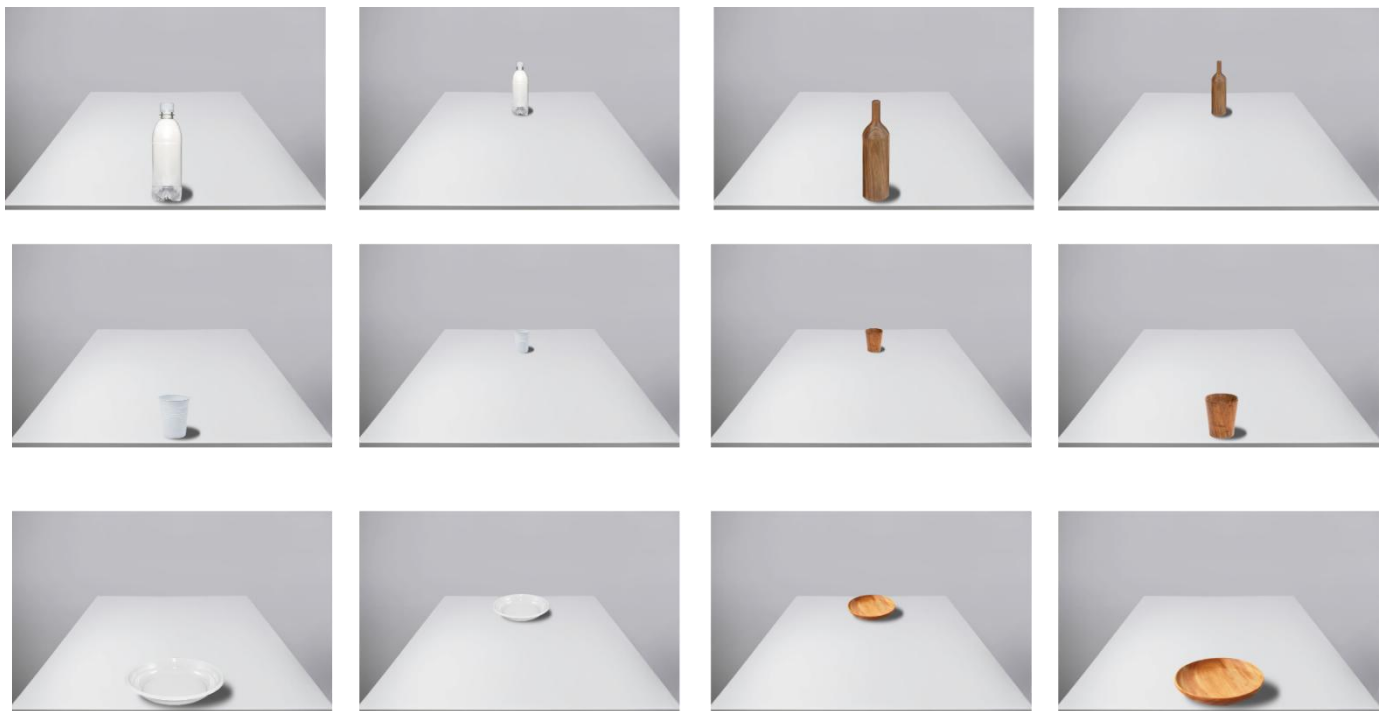


Figure 1. Bottle, cup, and plate, made of plastic and wood, and placed in the near or far-reaching position.

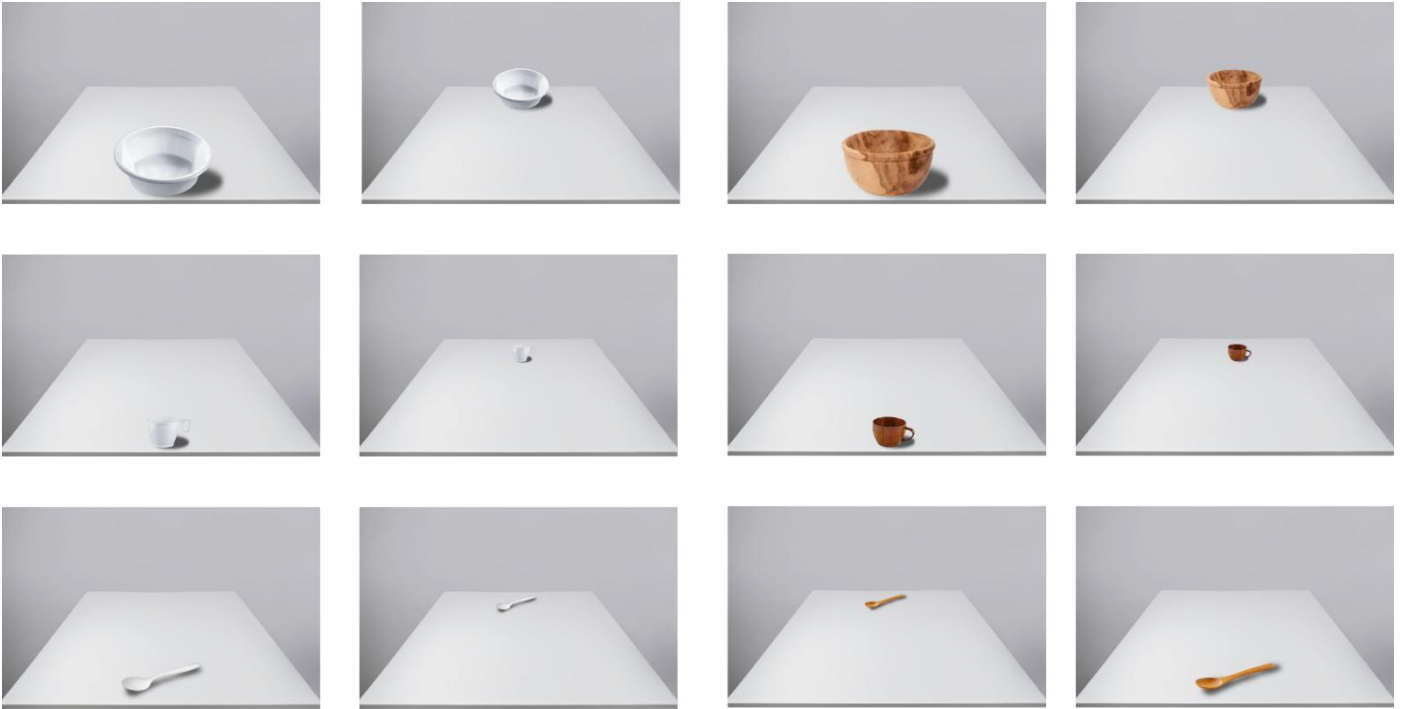


Figure 2. Bowl, small cup, and spoon, made of plastic and wood, and placed in the near of far-reaching position.

Finally, in regard to the modulation of the linguistic context, we used verbs associated with those categories of actions on which we intended to test our hypotheses. Therefore, we selected different Italian verbs in relation to these four classifications: function, manipulation, observation, and interaction (the full list of verbs is shown in detail in Table 1). With respect to the difference between manipulation and function, following Costantini et al. (2011a), we considered manipulation as all the grasping gestures accomplished to pick up an object (volumetric/manipulation), whereas we defined function as all the grasping gestures associated with using an object for its intended purpose (Bub et al., 2008; Pellicano et al., 2010). Hence, manipulation verbs are related to more generic action (e.g., “to take” or “to move”), while function verbs denote an action related to a possible final goal of that object use (e.g., “to drink”). Observation verbs regard the mere contemplation, and they are less specific than function or manipulations verbs, as they can be combined with all objects. Thus, in this case, we selected the same verbs previously used by Ambrosini et al., (2012), from which the frequency of use was checked. Finally, as interaction verbs, a new category within this paradigm, we intended those type of verbs that entail actions in which another person is

involved (e.g., “to offer” or “to pass”). The complete list shows also the incompatible verbs, namely those verbs that were needed to build up the experiment task and that denoted actions that could not be done with any of the selected objects (e.g., “to iron” or “to turn off”). Each verb was in the Italian imperative form (i.e., the grammar form used to express a command), and displayed at the center of the screen, with uppercase characters (56 pixels) in white (RGB: 256, 256, 256) on a black background (RGB: 0, 0, 0).

All materials have been made publicly available at the Open Science Framework (OFS) and can be accessed at <https://osf.io/f9ckn/>.

OBJECTS	VERBS				
	OBSERVATION	MANIPULATION	FUNCTION	INTERACTION	INCOMPATIBLE
Bottle (Bottiglia)	Osserva (watch)	Prendi (take)	Versa (pour)	Passa (pass)	Frulla (blend)
Cup (Tazza)	Guarda (look)	Appoggia (lay/put/place)	Bevi (drink)	Porgi (tender)	Pela (peel)
Small cup (Tazzina)	Fissa (gaze)	Afferra (grab)	Sorseggia (sip)	Offri (offer)	Spegni (turn off)
Bowl (Ciotola)	Osserva (watch)	Sposta (move)	Riempi (fill in)	Passa (pass)	Sfoggia (browse)
Plate (Piatto)	Guarda (look)	Posa (lay/put/place)	Mangia (eat)	Porgi (tender)	Sbuccia (peel)
Spoon (Cucchiaio)	Fissa (gaze)	Solleva (lift)	Mescola (mix)	Ricevi (offer)	Stira (iron)

Table 1. Verbs used for each object, grouped in the four different categories (observation, function, manipulation, and interaction) plus the incompatible. Each verb was shown in the Italian imperative form (expressing a command). Note that the English translation reported may vary for some verbs according to the context of use (e.g., “appoggia”).

5.3. Procedure

The study was conducted in the laboratory. The stimuli were presented on a 14” monitor from a viewing distance of 57 cm.

At the beginning of each trial, a white central fixation cross (10×10 pixels) was displayed for a duration of 100 ms. Then, the colored image appeared for 500 ms, followed by another white central fixation cross for 100 ms, and then by a verb presented at the center of the screen for 1500 ms. The experiment automatically switched to the next trial if the subject did not reply within 1500 ms, and the prior trial was not included in the analysis (see Figure 3). Participants were told to press a letter on the keyboard if the object-verb match was compatible (e.g., cup/drink) and to press another letter on the keyboard if not (incompatible-trials: e.g., cup/peel). The response letters “a” and “l” were balanced across participants (half of the subjects performed the task pressing the letter “a” when the match was compatible and the other half the letter “l”).

Participants completed 14,000 trials in two blocks of 7,000 trials, which included 9,648 compatible trials divided into two blocks of 4,824 trials each. All trial types were balanced and randomly interleaved. The two object positions, two materials, and five types of verb positions yielded 20 trial types. However, trials corresponding to different objects were collapsed during analysis, and the verbs corresponding to the incompatible actions were also discarded, finally yielding to 16 analysis conditions. Therefore, participants performed 288 trials per condition (192 compatible trials, 96 incompatible trials). We averaged the reaction times across the six object types to compute the mean reaction times per Material category (plastic, wood).

The experiment started with 30 practice trials. Between the two blocks, participants could take a short break. The whole procedure took approximately 30 minutes.

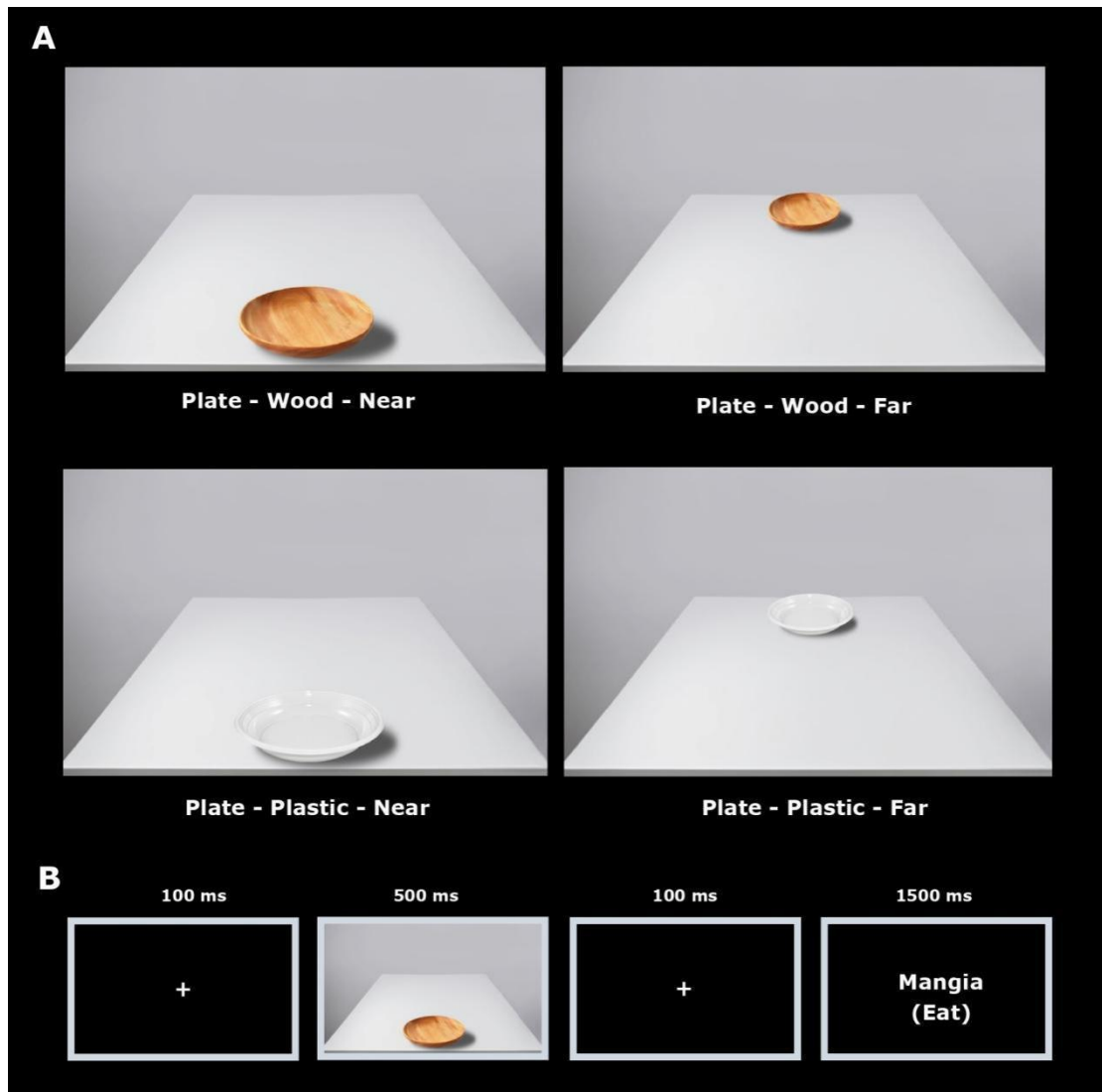


Figure 3. Example of experimental stimuli and paradigm. (A) Images of common-use plastic or wooden objects were presented on a table, either in the near or far space. (B) Experimental timing.

5.4. Psychometrics

Before the experiment, participants included in this study completed a computerized version of the Pro-Environmental Behavior Scale (PEBS) to assess self-reported environmental behavior (Marke, 2013; Italian version validated by Menardo et al., 2020). This measure is a 19-item scale (15 of the 19 original items retained in the Italian validation, the remaining 4 were not considered suitable for the Italian population), which covers a wide range of behaviors categorized into four types or dimensions (conservation, environmental citizenship, food, and transportation). The questions asked about participants' behavior choices (e.g., "How often do you cut down on heating or air conditioning to limit energy use?").

After the experiment, participants were asked to watch and rate the images shown in the experiment that were presented randomly with the subsequent questions. Beneath each image was a 7-point rating scale for seven dimensions that were also presented randomly: Familiarity, Sociality, Desirability, Pleasantness, Hardness, Heaviness, and Sustainability. For each dimension, participants were asked one question (e.g., for Familiarity: “How familiar is this object to you?”). The Sociality dimension concerned the level of sociality of the object, namely, how much it is used in a social context with other people (i.e., how much that object “evokes” individual or social contexts), and the question was “Would you use this object alone or with others?”, whereas for Desirability we asked “How much would you like to possess this object?”. All scales were labeled from 1- “not at all” to 7- “a lot”, except for Sociality which was 1- “alone”, 7- “with others”. After these ratings, for each image, subjects were asked to identify the surface material of the objects; all subjects answered correctly to this question.

5.5. Data cleaning, analysis, and final data set

First, we removed the trials in which participants failed to respond (0.8%), provided a response when it was not required (false alarms), or gave a wrong response (6.5%) from the RTs analysis. Then, responses of more than two standard deviations from the individual mean were treated as outliers and discarded from the analysis (4.78%). All the analyses were only performed on the valid trials (67% of the total trials). The descriptive statistics of the RTs were computed for each condition and presented as mean, median, and standard deviation (Figure 4).

To investigate possible differences in the average RTs between conditions, we performed a repeated-measures ANOVA with the within-subjects factors Material (Wood, Plastic), Object Location (Near, Far), and Verb (Function, Interaction, Manipulation, and Observation). The ANOVA revealed a significant main effect of Object Location ($F_{1,95} = 20.704$, $p < 0.001$, $\eta_p^2 = 0.008$), with faster RTs for Far compared to Near ($t_{95} = -4.55$, $p < 0.001$). We then performed the same analysis for each of the two blocks (see Figure 4 for the descriptive statistics of the RTs). For Block 1, the ANOVA revealed a significant main effect of Object Location ($F_{1,95} = 12.95$, $p < 0.001$, $\eta_p^2 = 0.120$), with faster RTs for Far compared to Near ($t_{95} = -2.66$, $p = 0.009$), whereas several significant effects were found in Block 2, including a significant interaction between Material, Verb, Object Location, ($F_{3,285} = 49.63$, $p < 0.001$, $\eta_p^2 = 0.138$). Since we found such different pattern of results in Block 2 compared to Block 1, we performed a repeated-measures ANOVA with the within-subjects factors Block,

Material, Object Location, and Verb, and we found a main effect of Block ($F_{1,95} = 19.7$, $p < 0.001$, $\eta_p^2 = 0.172$), as RTs were faster for Block 2 ($M = 656.65$, $SD = 117.55$) compared to those associated to Block 1 ($M = 707.56$, $SD = 103.12$).

To assess possible timing effect, we split Blocks 1 and 2 into four sub-blocks and performed an ANOVA with the within-subjects factors Sub-Block (1, 2, 3, and 4), Material (Wood, Plastic), Object Location (Near, Far), and Verb (Function, Interaction, Manipulation, and Observation), taking as condition levels the first 25% of the trials (Sub-block 1) and the last 25% of the trials of the block (Sub-block 4). In Block 1, we found a significant main effect of the Sub-block ($F_{1,98} = 9.09$, $p = 0.003$, $\eta_p^2 = 0.085$), and post-hoc comparisons revealed faster RTs for the last trials ($M = 689.99$ ms, $SD = 158.76$ ms) compared to the first ones ($M = 727.46$ ms, $SD = 133.83$ ms; $t_{98} = 3.02$, $p = 0.003$). Conversely, in Block 2, no effect of the Sub-block was found, thus indicating a possible learning effect within Block 1 (possibly due to a too short duration of the training session, since it consisted of only 30 trials, i.e., approximately 1 minute). Hence, in the results session we only report the significant findings from Block 2.

In regards to the different object proprieties investigated, we performed a series of ANOVAs in Block 2 by controlling for the ratings that subjects gave on the seven dimensions (Familiarity, Sociality, Pleasantness, Sustainability, Desirability, Heaviness, and Hardness) for each object and material, with the within-subjects factors Material (wood, plastic), Object Location (Near, Far), and Verb (Function, Interaction, Manipulation, and Observation). Consequently, we investigated possible correlations between RTs and either the ratings or the results on the PEBs. The internal consistency of PEBs and ratings was determined by the McDonald's hayesomega (ω) coefficient, following Hayes and Coutts (2020) recommendation. McDonald's omega coefficients were computed for the four dimensions of PEBS and for the seven ratings. The coefficients ranged from 0.372 (environmental citizenship) to 0.762 (food) for the PEBS, and from 0.773 (sustainability) to 0.855 (familiarity) for the ratings.

Violations of normality and homoscedasticity were assessed with a visual inspection of the normal quantile-quantile plots of the standardized residuals and with the homogeneity of variance test (Levene's test, Levene, 1960). Error analyses revealed a significant interaction between Material and Object Location ($F = 4.14949$; $p = 0.047$). No significant results were found in the post-hoc analyses. All the analyses were performed in Jamovi. The ANOVAs were performed utilizing the "afex" package (Singmann et al., 2015), and the level of statistical significance was set at $\alpha = 0.05$. Post-doc comparisons were Bonferroni corrected for multiple

comparisons. The coefficient ω was computed utilizing the “Factor” package in Jamovi 2 (Selker, 2017; Caldwell, 2022), which is part of the “lavaan” package for R (Rosseel, 2012).

5.6. Results

In Block 2, we found a main effect of Material ($F_{1,95} = 12.35, p < 0.001, \eta_p^2 = 0.115$), with faster RTs for Wood compared to Plastic ($t_{95} = -3.51, p < 0.001$), and a main effect of Verb ($F_{3,285} = 13.98, p < 0.001, \eta_p^2 = 0.128$). Specifically, RTs were faster for the Function verbs compared to the others (higher $p = 0.002$) and faster for Interaction compared to Observation ($p = 0.037$). Further, a significant result was found for the interaction Verb-Material ($F_{3,285} = 24.06; p < .001; \eta_p^2 = 0.060$), namely within the Interaction Verb category, with faster RTs for Interaction-Wood than for Interaction-Plastic ($t_{95} = -8.626, p < .001$).

The most relevant result was a significant interaction between Material, Verb, Object Location, and Block ($F_{3,285} = 27.75, p < 0.001, \eta_p^2 = 0.226$). On Function trials, RTs were faster for plastic objects compared to wooden objects in the near-reaching space ($t_{95} = 6.045, p < 0.001$). A different RTs pattern was observed for Observation trials, where we found that RTs were faster for plastic objects compared to wooden objects in the far-reaching space ($t_{95} = 5.58, p < 0.001$). Here, we also found that RTs were faster for wooden objects compared to plastic objects in the near-reaching space ($t_{95} = -7.41, p < 0.001$) and faster for plastic objects in the far compared to the near-reaching space ($t_{95} = -9.21, p < 0.001$). Finally, in the Interaction trials, we found that RTs were faster for wooden objects in the far-reaching space compared to wooden objects in the near-reaching space ($t_{95} = -8.14, p < 0.001$), as well as plastic objects in the far and near-reaching space ($p < 0.001$). Moreover, RTs associated with plastic objects were faster in the near- compared to the far-reaching space ($t_{95} = 4.81, p = 0.003$). We found no significant differences between RTs for objects with different materials and presented at different locations for Manipulation.

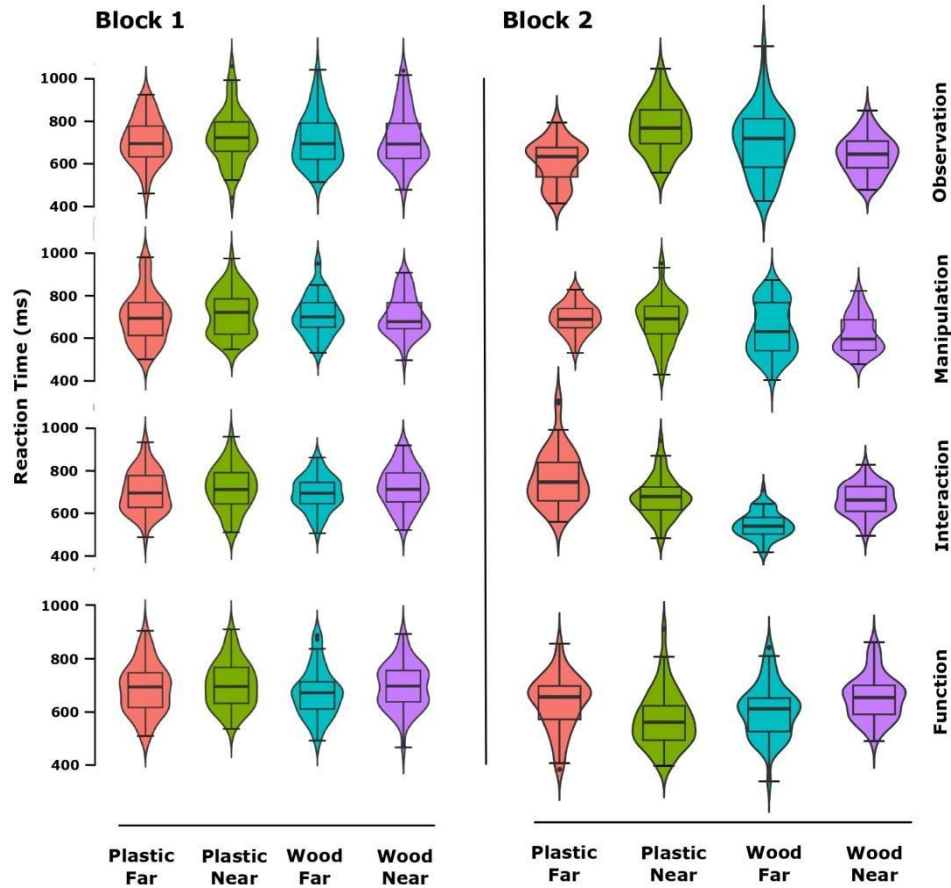


Figure 4. RTs across objects, materials, space, and verbs. The figure shows the violin plots with the superimposed box plots of the RTs plotted independently for the two experimental blocks. The violin plots show the distribution of RTs for each verb category and for material/distance. The box plots show the median rating (the dark horizontal lines), the 75th percentile to the 25th percentile (the boxes), and the upper and lower boundaries 1.5*75th (or 25th) quartiles (the whiskers).

In regard to the different object proprieties assessed through the ratings, we found that, as predicted, plastic objects were evaluated as significantly more familiar than the wooden ones ($p < 0.001$), while these latter were evaluated as significantly more pleasant (beautiful), desirable, heavy, and hard ($p < 0.001$). Further, sustainability ratings confirmed our manipulation choice, since wooden objects were rated as significantly more sustainable than the plastic ones ($p < 0.001$). No difference was observed between wood and plastic regarding the Sociality scale. Descriptive statistics are reported in Figure 5.

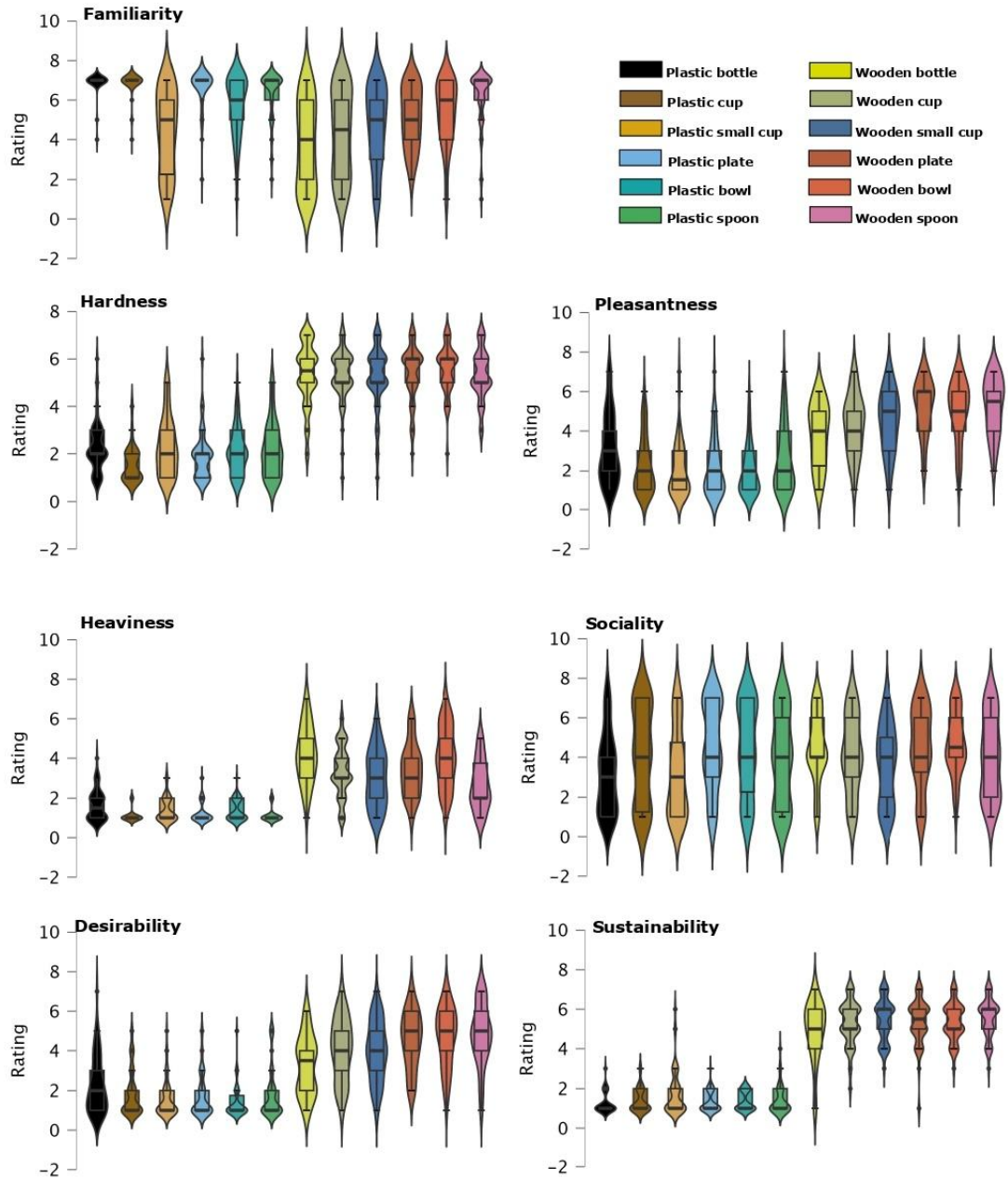


Figure 5. Ratings across objects and materials. The figure shows the violin plots with the superimposed box plots of the ratings plotted independently for the seven dimensions (Familiarity, Hardness, Heaviness, Desirability, Pleasantness, Sociality, and Sustainability). The violin plots show the distribution of ratings for each dimension. The box plots show the median rating (the dark horizontal lines), the 75th percentile to the 25th percentile (the boxes), and the upper and lower boundaries 1.5*75th (or 25th) quartiles (the whiskers). Ratings were provided on a scale from 1 (*not at all*) to 7 (*extremely*).

Since ratings confirmed our predictions about the several proprieties modulated by the change of the material element, we thus checked for any correlation between the RTs obtained

in the different conditions for which we found significant results, and each single rating. For the wooden objects, we found a negative correlation with Familiarity ($r = .29$; $p = 0.017$). For the condition Observation-Plastic-Far, we found a significant negative correlation with Familiarity ($r = -.11$; $p = 0.038$) while for the Observation-Wood-Far condition we found a significant positive correlation with Desirability ($r = .12$; $p = 0.028$). For the condition Interaction-Wood-Far, we found a significant correlation with Pleasantness ($r = -.13$; $p = 0.031$), and with Desirability ($r = -.12$; $p = 0.042$). For the Interaction-Wood-Near condition, we found a significant interaction with Hardness ($r = .13$; $p = 0.029$). All in all, these correlations provide useful insights into the interpretation of the RT's results, specifically in relation to the familiarity of plastic objects, and to the beauty and desirability of wooden objects.

In regard to the PEBs (Menardo et al., 2019), results confirmed the comparability of our sample, since only two participants had a mean score above 4 (out of 5), thus the average scores obtained on the scale ($M = 3.14$; $SD = 0.467$) indicates that they were not ascribable to a significantly different behavior in relation to the environment. Finally, we assessed if the pattern of results found in Block 2, showing differences between materials, object locations, and verbs, could be correlated with the PEB. We found no significant correlation between the RTs of our different conditions and both the PEBs total score and the scores obtained for each sub-scale.

5.7. Discussion

In cognitive science and experimental psychology, most of the empirical research has studied affordances in relation to the design of common objects, focusing mostly on their shape and size (e.g., Ellis & Tucker, 2000). Here, we explored the modulation of affordances in relation to the material from which objects are made. Materials are not only a fundamental component of the object's aesthetic expression and functionality (Barati & Karana, 2019), they also can play a crucial role in the appreciation and evaluation of it (Harper, 2018). Particularly, this aspect pushed us to interweave affordance research methodology with some theoretical premises related to the perception of an aesthetic experience (Pelowski et al., 2016). Thus, in investigating the activation of affordances in respect to materials, the present study takes into account the role that aesthetics may play in stimulating or inhibiting this process, since our

tastes, preferences, and evaluations, can constitute a crucial influence on the objects perception (Stich et al., 2007), and thus on our response times toward it (Righi et al., 2017; 2014).

To measure response times, we adopted the paradigm employed by Costantini et al. (2011a) and Ambrosini et al. (2012). Indeed, rather than isolated, we intended to study the role of the material component in a more ecological/realistic way, thus integrating it within a physical and linguistic context. Hence, we used a paradigm which represents a well-established method to study affordances in relation to these two components, implementing it with some crucial changes. First, we added a new independent variable, the surface material. Second, since their results showed that an object suggests an action only when it falls within the actual reaching space of the perceiver (i.e., when an actual interaction is possible), we applied only two object distances (namely, near and far) to integrate the physical context in our design. Finally, we replaced the pointing verbs with a new category, the interaction verbs (i.e., verbs that entail actions in which another person is involved). This choice was based on our interest in investigating the social dimension of certain actions, as well as the sociality evoked by the objects (i.e., how much is associated with a social context) in respect to their material components (item measured in our ratings). In addition, we also checked our manipulation in two ways: we collected self-reported ratings on several proprieties of the objects that the change of material inevitably brings about, and we checked the participants' habits to act in favor of the environment, measuring pro-environmental behavior.

In regard to the ratings, results confirmed our predictions, as plastic objects were rated as significantly more familiar, while wooden objects as more heavy, hard, desirable, pleasant (beautiful), and sustainable. In regard to PEB, the average score obtained on the scale (Menardo et al., 2019) confirmed the comparability of our sample, since participants were not ascribable to a significantly different behavior in relation to the environment. Indeed, PEB is the result of individual environmental attitude, norms, values, concerns and beliefs (Ajzen, 1991; Stern, 2000). Therefore, the PBS scale is representative for individual personal traits and knowledge. Predictive coding theories (Clark, 2013) and the affordance competition hypothesis (Cisek, 2007) suggest that our prior knowledge influences our perception from an earlier stage of processing, and we know that object properties are contained in stored knowledge built up from the past (Osiurak et al., 2017). Thus, since we compared two materials perceived significantly different in terms of their sustainability (i.e., impact for the environment), we needed to check for any correlation with the PEBs scores, and make sure that there were not significant individual differences among the participants. As will be discussed here, both results, ratings and PEB, can provide useful insights into our interpretations.

The experimental session included a break that divided the responses into two blocks of trials. As shown in the data analysis, a significant effect of the Block factor was found, with faster RTs for the second one, and also a significant effect of the sub-block factor within Block 1, with faster RTs for the last sub-block. This surprising difference between the two blocks led us to assume that a learning effect occurred in the first block (possibly related to the short training session), thus invalidating those results. Therefore, the following discussion will regard the significant results found in Block 2, and that concern three major points: the two main simple effects founded for (1) wood as material and for (2) function as verb category, and the specific results related to (3) the interaction between the three main independent variables.

5.7.1. Main effect of the material: the advantage of wood.

We observed a main effect of materials with RTs faster for wooden objects compared to plastic ones. This result was surprising since we were expecting plastic objects to be advantaged for their familiarity (Haber & Hershenson, 1965; Jacoby & Dallas, 1981). Familiarity is one of the key normalization parameters for everyday objects (Snodgrass & Vanderwart, 1980), embedded in know-how (Riemer & Johnston, 2014), related to specific contexts and accumulated through practice or experience (Turner, 2005). Specifically, plastic objects are very familiar and frequently used in Italy (e.g., Campanale et al., 2019; Foschi et al., 2021), and both features, object familiarity and frequency of use, can be determinants for the activation of affordances (Rio, 2019). Nevertheless, this result shows that wooden objects had an advantage despite being non-familiar and less used. For some theories of visual perception (Varadarajan, 2011), the material should be considered as one of the key features for affordances (along with, e.g., shape and color), on which object recognition is grounded and through which humans are capable of categorizing previously unseen objects with uncharacteristic texture into its right class, without a priori knowledge (Varadajan & Vincze, 2012, p. 515). If this argument upholds, the advantage found for wood might not be related to the familiarity or frequency of the use of the respective objects, but instead to some other intrinsic propriety of the material.

Concerning the different object proprieties, wooden objects were rated as significantly more heavy, hard, desirable, and beautiful. We exclude the influence of the first two (hardness and weight) since they should have rather disadvantaged wooden objects compared to the lighter plastic ones (Anelli et al., 2010). Possibly, the absence of any reaching or grasping task might have attenuated the influence of these two features. Hence, there could be reasons to

associate this result with the aesthetic attractiveness and desirability of wooden objects. Indeed, beauty is less dependent on a grasping task (unlike hardness or heaviness) or on a more reflective evaluation (as it is for sustainability), and we know that aesthetic attractiveness can influence the performance toward the object (Righi et al., 2014, 2017; Reppa & McDougall, 2022, 2015; Han et al., 2016;). Studies about beauty have demonstrated that liking can be connected to an initial aesthetic-perceptive network, which starts very early (Cela-Conde et al., 2013), and that our affective processes in relation to aesthetic experience also start at the early stages, influencing the salience and attention toward the beautiful object (Leder et al., 2004, 2014). Moreover, pleasant emotions derived from beauty may also be related to surprise and novelty induced by something perceived as not ordinary (Pelowski et al., 2017). Indeed, the appraisal of novelty and the disruption of processing expectations are linked to the kind of pleasure derived from beauty (Armstrong & Detweiler-Bedell, 2008). In this light, we could thus associate this result with the negative (and only) correlation that we found between RTs with wooden objects and Familiarity, showing that faster responses are correlated with the non-familiarity of those objects. Perhaps, as Harper (2018) suggests, the pleasure of sustainable objects lies also in their ability to disrupt the user's comfort zone, and the use of unexpected materials confront our powers of perception and conception. Indeed, novel stimuli may elicit more attentional orienting (Desimone et al., 1995).

Nevertheless, in regard to desirability, participants' evaluations for wooden objects might have been influenced by the fact that they inferred the study to be on sustainability. Though, if filling the PEBs questionnaire before the experimental session could somehow bias their initial approach, collecting participants information about their environmental attitudes or behaviors may be considered as a common procedure for studies on sustainability (Grilli & Curtis, 2021). Furthermore, although we cannot be completely sure about this possible influence, participants did not know about the study focus on sustainability, rather, they knew it was about the perception of everyday objects made of different materials, and the experimenters also stressed the anonymity of data and recommended to be as truthful as possible in one's answers when giving ratings on the objects.

All in all, our impression of this finding is that wooden objects might have activated affordances that are more related to their aesthetic proprieties (such as beauty, desirability and novelty), rather than to their use or function. The results found on the interaction between our variables (§ 5.7.3) seem to provide further evidence for this interpretation.

Though, one possible objection could be that, rather than the aesthetic attractiveness, the advantage (i.e., faster responses) for wooden objects might be driven by color. Indeed, material is an element characterized by different components, such as texture, color, or brightness, and it is not easy to discriminate how all these features interact with our perception (Treisman, 1998). In the present study, the change of material for our stimuli also involved a change in color, which can affect object recognition (Gevers & Smeulders, 1999; Bramão et al., 2011). In this regard, literature is divided between *edge-based* and *surface-plus-edge-based* theories. The former theories claim that objects are initially recognized solely on the basis of their shape. In contrast, according to the second ones, surface information such as color or texture can facilitate the process (Tanaka et al., 1999). Empirical results are mixed. Some studies have shown that participants are neither faster to recognize appropriately colored objects than their gray-scale versions (Biederman & Ju, 1988; Davidoff & Ostergaard, 1988), nor slower to recognize inappropriately colored objects than the appropriate ones (Ostergaard & Davidoff, 1985), leading researchers to minimize the role of color information (Biederman & Gerhardstein, 1993). Yet, it has also been shown that colored objects can be recognized faster than monochrome objects (Humphrey et al., 1994; Wurm et al., 1993), inappropriately colored objects (Joseph & Proffitt, 1996), or black and white and gray-scale images (Mapelli & Behrmann, 1997). It is most likely that the influence of color and shape on object recognition goes beyond the dichotomy between *edge-based* and *surface-plus-edge-based* theories. In this respect, Tanaka and colleagues (2001) showed that, even if object recognition is primarily a shape-driven system, color plays a supporting role in the recognition of high color-diagnostic objects and scenes (i.e., objects strongly associated with a particular color). Most importantly, color effects are more likely to occur in the recognition of natural objects than in the recognition of artifact objects (Tanaka & Presnell, 1999, pp. 1151): “objects from natural categories (e.g., fruit, animal, vegetables) tend to be structurally similar (Price & Humphreys, 1989) and have prototypical colors. In contrast, objects from artifactual categories (e.g., tools, furniture, appliances) are more structurally divergent and generally lack characteristic colors”. For instance, Garofalo and Riggio (2022) investigated how color influences the motor representation of graspable objects, showing that reaction times for natural objects were faster than those related to the artifact objects. Overall, color can improve object recognition, but mostly for color diagnostic objects, such as natural objects, since only marginal color effects were found in studies that used non-color diagnostic objects (Bramao et al., 2011). Object recognition requires the flexible integration of color and shape, the impact of which is modulated by the stimulus and the task at hand, with shape playing a more dynamic and potent

role than color, due to its privileged relationship with action (Scorolli & Borghi, 2015). In our study, all types of objects are man-made artifacts which are not strongly associable with a specific kind of color per se (i.e., no color congruence dispute), and even within their material category, they could be found in different samples (e.g. plastic bottles, cups or plates can display several different colors), or with different color ranges (as is the case for the different varieties that processed wood can have). Tanaka and Presnell (1999) showed how color affects the recognition of high color diagnostic objects (HCD), but not of low color diagnostic ones (LCD), which brought them to affirm that color plays a role in the recognition of objects with strong color associations (e.g., banana-yellow). Moreover, the color advantage for individual HCD objects can fluctuate across experiments, and it is more likely to be found in studies that use a wide range of stimulus objects (Price & Humphreys, 1989). In our study, the objects are not considerable as HCD (none of those have been used as such in the previously cited researchers), and they are not representative of a prototypical sample, especially the wooden ones which for the most part are unfamiliar objects (confirmed by the ratings). Therefore, the advantage for wood in the present study cannot be explained in relation to the color diagnostic hypothesis.

Nevertheless, it cannot be ignored that specific color's features, such as brightness or saturation, might have influenced the responses. However, all our stimuli were artifacts, and color affects the recognition of natural objects more than of artifacts. Therefore, it is possible that brightness or saturation influenced the object's attractiveness more than its mere recognition. For instance, the study by Chen et al. (2017) clearly shows that color attractiveness is influenced by brightly saturated colors (the brighter the artifact is, the more attractive it appears to be, especially for the monochromatic furniture), capturing the user's first glance. Though, despite the emergence of this color-brightness effect, this does not forcibly have an influence on color affordance, leading the authors to affirm that “the results also confirm the affordance theory of Gibson: when we look at objects, we normally first pay attention to what the object affords us, not to its qualities (Gibson, 1979)”.

Another possible criticism might be that the plastic objects stand out less against the table background than the wooden ones. We know that, at the lower level of recognition, color may help to differentiate objects from the background, but at the higher level, objects and scenes imbued with characteristic colors are recognized more readily when seen in their natural colors than when not (Tanaka et al., 2001; Garofalo et al., 2021). In our case, this argument does not uphold because there are no natural colors for the presented objects. In terms of recognition, there is still a difference between the two object classes. However, this could be

driven by familiarity, with plastic being more familiar and closer to the prototypical color of the corresponding objects (e.g., canonical tableware is often grey). Yet, for both sets of objects, we can consider that their color was congruent within its material category. Indeed, in the ratings questionnaire, when participants had to write down what material each object was made of, they always provided the correct answer. Thus, each image is a plausible representation of the object in question, and despite their difference in the color range and in the luminance, we still found stable effects within the same material.

In sum, early object recognition stages appear to be affected by color knowledge, i.e., only when familiar everyday objects are associated with their canonical colors (Lu et al., 2010), and this was not the case, and the color brightness of wood (compared to plastic) may have enhanced the objects' attractiveness and in turn their affordance. As such, this effect could therefore be associated to the object's aesthetic pleasantness rather than to ease of recognition.

5.7.2. Main effect of the verb category: the advantage for function verbs

Moreover, a main effect of verb was found. As expected, Function was the verb category associated with faster RTs compared to all the others, i.e., Manipulation, Observation, and Interaction. The advantage for function verbs over manipulation and observation verbs indicates that objects are represented in terms of their use. This is in line with previous evidence with the same paradigm that involved linguistic stimuli (Ambrosini et al., 2012; Costantini et al., 2011a). Other studies have found that structural-volumetric responses are activated faster than functional actions (e.g., Jax & Buxbaum, 2010). However, contrary to our work, these studies focused on conflict objects, i.e., objects that evoke two different grasping actions for manipulation and function, and they did not employ linguistic stimuli combined with object images.

5.7.3 Significant interactions between material, verb category, and object location.

Importantly, we observed several significant interactions between materials, verbs, and object locations. As expected, results showed significantly greater facilitation for plastic compared to wooden objects when presented in the near space and followed by function verbs. Indeed, function verbs seem to have a strong connection with plastic objects, which may be consistent with the fact that plastics are tightly related to their functionality (Evide et al., 2021).

Language has a privileged relationship with function (see, for instance, Kemler Nelson et al., 2000; Masson et al., 2008), and the use of plastic in the last decades has increased as never in history (Freinkel, 2011). Furthermore, ratings results showed that plastic objects were rated as significantly more familiar. Hence, the simulation conveyed by function verbs in the near space may have been stronger with plastic objects, likely because they are the more commonly used and familiar.

With observation verbs, in the near space responses were significantly faster for wooden objects. This advantage is in line with our predictions, since we consider the aesthetic attractiveness to be crucial within this case, and wooden objects were judged as the most beautiful. Indeed, the nature of beauty is self-oriented rather than goal-oriented (Hassenzhal, 2004), and observation verbs might activate a sort of aesthetic encounter more than in the other cases, since, contrary to the other verbs category, the action toward the object concerns the mere contemplation and not its use. Thus, this interpretation would be in line with the phenomenological dimension of an aesthetic experience (Shustermann, 1997), for which we may have a shift in attention from goal-directed to aesthetic-directed. In this case, the affordances activated by the wooden objects (which are rare and less used) may be of a sort of different nature from those activated by the plastic ones (more familiar and commonly used), the former being more of an aesthetical kind, i.e., *aesthetic affordance* (Sanchez, 2022). Interestingly, this effect did not involve the far space, where instead responses were significantly lower for plastic objects (even compared with wood-far and plastic-near). In relation to this result, we found a significant negative correlation of Familiarity with the Observation-Plastic-Far condition, showing that shorter responses correlate with greater familiarity of the objects. Notably, observation is easier and more effective when objects are close (Shelton et al., 1990), whereas objects placed in a far-reaching position may lose salience (Hoffman & Singh, 1997). In this case, when placed closer, the wooden objects were more salient than the plastic ones. Conversely, lack of salience might have led to a more automatic way of perception, possibly favoring the more familiar elements (i.e., plastic objects).

Finally, with interaction verbs, a general advantage for wooden objects was found. Contrary to observation verbs, with this category the effect seems more pronounced when the objects are placed at a far distance (non-reachable) rather than near. Indeed, responses in the wood-far condition were significantly faster compared not only to the plastic-far, but also to the plastic-near and wood-near condition. Though, we observe also that the responses in the wood-near condition were significantly shorter than the plastic-far ones, and the plastic-near condition was still significantly faster than the plastic-far, so an advantage due only to the

distance variable (i.e., the far-reaching condition) needs to be excluded. Instead, a specific interplay between two variables is present within the interaction-verbs category, where wooden objects have a predominant advantage, especially when placed in a far-reaching space. Interestingly, for the Interaction-Wood-Far condition, we found a significant positive correlation with Pleasantness (beauty) and Desirability (desire to possess), showing that faster responses correlate with greater evaluations on these two proprieties. Differently, for the Interaction-Wood-Near condition, a positive correlation with Hardness was found, meaning that greater response times correlate with greater estimation. Interaction verbs have never been used with this kind of paradigm, and to our knowledge there are no previous tests of its modulation in relation to the object's distance from the perceiver, the influence of which may be not as straightforward as it is, for instance, for functionality. Indeed, these types of verbs concern actions done in cooperation with someone else, and the hypothetical presence of another person can influence affordances in unexpected ways (Scorolli et al., 2016). We could assume that in certain case it may accelerate responses in the near space (e.g., for the verbs “to pass” and “to tender” the command and final goal is to give it to someone), while in other it could bring an hesitation (one of the interaction verbs was “to receive”), or it can interfere with a sense of ownership (e.g. with the verb “offer”). Specifically, in our study, we expected a difference between plastic and wood in relation to their value (Felippin et al., 2024). Indeed, the fact that wood comes from natural and meaningful living things, such as trees, may mediate the value afforded to this material and its processing (Sands, 2022), and thus, the durability and re-usability make wooden objects as perceived of high value (Ilker, 2016). Conversely, this does not apply in the same way with man-made objects (Ismail et al., 2019), especially the plastic ones that are commonly regarded as more disposable (Oberoi & Garg, 2021; Oberoi et al., 2021), since almost half of the total production of plastic is manufactured for single use (Hopewell et al., 2009). Therefore, within the interaction frame, the hardness and preciousness of wood might have slowed down responses in the near space, being mostly actions that evoked a “giving” to someone else (whereas it did not happen with plastic, for which the near space was still significantly faster than the far), whereas, conversely, its desirability could have fastened it in the far space, as if the objects belonged to someone else who performs the action.

In sum, the introduction of the material component as a variable within this paradigm showed how the physical and linguistic context can produce different interactions in relation to the social, cultural, and aesthetic proprieties of an everyday object. Functionality (i.e., the goal of use) proves to be a dominant factor for affordance activation, insofar as the object is

familiar and commonly used. Instead, observation verbs, inviting toward a mere contemplation of the object, might be influenced significantly by its beauty. Interaction verbs, in turn, entailing the presence of another person, might involve other relational mechanisms with the object, such as its desirability. Interestingly, Berridge et al. (2009) showed how brain networks related to *liking* represents pleasure unrelated to the desire for possession, whereas *wanting* is related to the desire for the object and connected with the actions necessary to satisfy that desire, and the two mechanisms seem mediated by different neural circuits and neurochemical systems (Yue et al., 2007; Nadal, 2013; Tibboel et al., 2015). Here, the advantage for wooden objects in the far space might be related to the activation of aesthetic networks more linked to the desire of the object (i.e., *wanting*), rather than those related to the mere contemplation of its beauty (i.e., *liking*), which instead might have been more active in the near space, as for the case with observation verbs. The possible correlation between these kinds of networks related to the perception of beauty, and the affordance modulation applied by different linguistic elaboration of action and different objects' materials, could represent a fascinating direction for future developments of this research.

5.8. Limitations

The present study has indeed some limitations. First, although the ratings generally confirmed our predictions about the objects' perceived familiarity and sustainability, the object pairs did not have exactly the same shape in their respective materials, and they did not individually have the same degree of familiarity. We decided to keep objects that were slightly different because we wanted to use pre-existing everyday objects rather than building stimuli ad hoc.

Second, participants did not have any reach-to-grasp movement to perform (as was the case for Ambrosini and colleagues, even if just simulated toward the computer screen), something that perhaps could have helped the perceived motor simulation. Without any gesture, probably the haptic dimension of the objects was poorly considered within the task/paradigm, leading certain proprieties such as heaviness or hardness to be possibly less influential in respect to other more strictly visual and affective such as beauty and desirability.

Furthermore, we did not check the brightness and the background contrast of the materials. We did not manipulate the color properties of the images in order to preserve the ecological character of the stimuli and because a person's aesthetic preferences are also related to the colors of objects (Palmer & Schloss, 2010). Also, some researchers affirm that normal

recognition must be based on shape information alone (Biederman, 1987; Grossberg & Mingolla, 1985), and indeed, the action-based property of shape seems to be more crucial than color (Scorolli & Borghi, 2015), the latter having an important role mostly with natural color diagnostic objects (Bramão et al., 2011). Nevertheless, a clear challenge of this study was our inability to differentiate the specific and direct impact of each of these color properties on subjects' RTs, thus limiting the weight of our assumptions on the main effects found for wooden objects. Future studies should consider the contribution of each of these dimensions to subjects' ratings and perceptual affordances.

Finally, measuring pro-environmental behavior by self-reports always involves some limitations, and the failure to find any correlation of it with the responses might be due to the choice of measure used. Indeed, although we employed young participants and used the well-adapted version of the questionnaire to the Italian context made by Menardo and colleagues (2019), scores were not as high as we expected. For only two out of four PEB sub-scales (namely, Conservation and Transportation) we found high scores, probably because in the context where the participants were recruited (Bologna, Italy) bikes and public transportations are frequently used and well implemented (Bertini et al., 2023; Sperati & Colazzo, 2018). Conversely, we found low mean scores for the Environmental Citizenship and Food sub-scale. For possible future development or research on affordances modulation by everyday object in relation to the sustainability of the materials, it might be rather more suitable to perform a pre-assessment by measuring attitude (Dunlap et al., 2000) and other fixed individual values related to it (Gansser & Reich, 2023).

5.9. Conclusions

The present study contributes to the affordance research, providing insights into the different modulation that may take place with everyday objects made of different materials. When comparing the same objects, the change of material can entail a significant change in the object's aesthetic attractiveness, possibly leading to an advantage in the affordance activation due to its beauty. Further, following a well-established paradigm, we investigated the effect of this change within a physical (object location) and linguistic (actions conveyed by verbs) context. This design confirmed the strength of functionality, which here was specifically related to plastic objects, possibly due to their familiarity and frequency of use (i.e., our social and cultural practices). At the same time, different specific and distinctive effects arise when the object's aesthetic and position intertwine with actions that concern a mere observation or

cooperation with another person. We hypothesized that, in both cases, some qualities brought about by the material might be crucial for the outcome of affordances modulation, such as beauty and desirability of the object. In any case, beyond the limitations of our interpretations, the present study shows that wooden and plastic objects brought to different vision-action coupling, a result that we hope will stimulate future research on the role that materials can play in influencing everyday objects' visual perception, attraction, and readiness for action.

CHAPTER VI

STUDY 2

Aesthetic Experience and Emotions

6.1. Introduction⁹

The present work shows the preliminary results of a pioneering project aimed at comparing the aesthetic experience of a musical concert lived in-presence with the same concert experienced in not-shared spatial and temporal dimensions. There are currently several alternatives to the live event experience: we encountered them on a massive scale during the pandemic. In our homes we familiarized ourselves with both traditional streaming (e.g., a movie on Netflix or other digital platforms) and “live streaming” (e.g., a concert on YouTube or Twitch). From the perspective of the user, live streaming has the advantage of reaching the audience in the shortest time, favoring the sense of presence. From the perspective of IT developers, in turn, it is challenging for the large amount of data and information to be created in a few seconds and sent immediately to users. The sense of presence is even stronger in a virtual world, which is symmetrically much more complex to implement – the ultimate exponent of it being the “metaverse”. This product combining physical and virtual reality can provide enhanced immersive experiences in a space-time structure identical to our physical universe.

Psychologists and philosophers are familiarizing themselves with these new experiences, reasoning on their possible implications and new research questions. Intriguing in this regard is the proposal by Atherton and Wang (2020) of a practical philosophy oriented toward developing design principles of artful musical VR. Computer scientists are chasing each other in the realizations of “digital twins” that are increasingly effective in replacing both objects and real agents, adapting to different contexts. Artists, unencumbered by research

⁹ Scorolli, C., Naddei Grasso, E., Stacchio, L., Armandi, V., Matteucci, G., & Marfia, G. (2023). Would you rather come to a tango concert in theater or in vr? aesthetic emotions & social presence in musical experiences, either live, 2d or 3d. *Computers in Human Behavior*, 149, 107910. doi.org/10.1016/j.chb.2023.107910
This study is a published work. The following report has been slightly extended for the purpose of the present thesis.

objectives, are variously directing their creative thrust. In the musical field, which we are most interested in here, consider for instance the recent experimentation by Travis Scott (2020): his musical concert in Fortnite has been one of the most attended live events in VR.

Beyond the daring artistic endeavors, which range across different fields, the present project moves from a collaboration among scholars who, from different perspectives (i.e., psychology, philosophy, computer science) have been questioning how to clearly structure research work on immersive experiences in virtual environments. We decided to proceed incrementally: starting from a well-circumscribed field of investigation and bounding the theoretical questions accordingly. For different reasons, the field we have chosen is that of virtual environments recreating aesthetic experiences, circumscribing (for now) the analysis to the musical ones. Indeed, as it will be shown, this allowed us to test the emotional response to the experience also in respect to different expectations and motivations.

To understand whether and how these aesthetic (and social) experiences and their respective emotions and motivations are systematically modulated (i.e., not just because of the temporary ‘novelty effect’) by differently immersive settings, we must select physical and social environments for which the degree of immersiveness is incrementally increased. Consistently, we contrasted the classic experience of a live concert (LC, in presence) with three “remote” conditions, not simultaneous with respect to the event: the experience with audiovisual musical files (MV, the classic viewing of a concert on YouTube) and two experiences lived thanks to a less or more sophisticated eye-mounted apparatus for virtual reality (VR), i.e., google cardboard (CVR) and an HTC Vive (HVR). The CVR and the HVR allow respectively for a basic and easily accessible experience vs. a less affordable but more immersive experience. Both the devices permitted a three-dimensional vision: by moving the head or the whole body, participants could have a 360° view, namely, an overall vision of the concert venue, including musicians and audience – together with their possible reactions to a virtuosity or a false note played by the performers.

For this novel field of research, there is not yet substantial empirical literature. It took shape from hands-on needs arising in the context of the COVID-19 pandemic (Merel, 2020), but it is of considerable interest also from a theoretical point of view. The aesthetic social experience strongly influences the shaping of identity: it allows bodily effects-affects to re-emerge, consistently with psychological approaches enabling the re-enactment of the bodily self (Scorolli, 2019). In this sense, it could be considered as a novel and privileged means for approaching the acting-sentient bodily self in a dynamic-social and affective environment. The emergence of a coherent identity not only affects the well-being of the individual but is also

fundamental in the development of the self, particularly during adolescence. In aesthetic experience (in the broad definition of which we can include, for instance, reading a book or listening to a piece of music) we are immersed in an interaction in which we participate without controlling what happens. The contents of the environment become an integral part of the same (extended) mind to which we feel we belong (Matteucci, 2019). In perceptual and emotional interaction, expressive artifices concur to aesthetically construct our bio-cultural niche (Matteucci, 2020, 2021).

The aesthetic experience *in everyday contexts* is still little investigated by cognitive science: among the reasons there is the difficulty in collecting data and creating equally controllable and comparable experimental conditions. Another issue can be ascribed to the challenge in converging on a ‘good’ definition of aesthetic experience. In this regard a recent and inspiring work is the special issue by Mastandrea, Tinio, and Smith (2021) on aesthetic experiences addressed in different contexts: we endorse the authors' definition as “people's interactions with, and reactions to, objects, places, but also to the environment” (see also Tinio and Smith, 2014).

This novel area of investigation does have the merit of taking empirical research out of the laboratory and re-thinking the places of art as possible experimental labs and places of contact, interaction, and inclusion. Moreover, it fits well with the new institutional mission of the Academia. Alongside the traditional missions of teaching and research, nowadays the Academia must be engaged in fostering the scientific, technological, and cultural transfer of knowledge, through processes of direct interaction with society: the goal is to promote the social growth of the territory, so that knowledge becomes instrumental in obtaining benefits of social, cultural, and economic nature.

A further value of the perspective proposed lies in its interdisciplinarity. Psychologists, philosophers, virtual environment developers, and artists are engaged in the jointly effort to explore the relationship between the aesthetic experience and the individual's self-awareness but also innate needs (Yu, 2016; Yu and Wang, 2018), consistently with the hierarchy proposed by Maslow, in which aesthetic needs even precede personal self-realization (Maslow, 1954; 1992; Ward and Lasen, 2009).

Finally, among the innovative features of this research, we point to the emphasis on new technologies. Throughout our evolutionary history, our cognitive systems have been profoundly changed with the advent of technological inventions such as primitive tools, writing, and arithmetic systems. Immediately following the advent of the Internet, the

progressive development and spread of Virtual Reality environments are profoundly reshaping the human mind, our feelings, our interactions, and our way of life.

Despite the usefulness of VR paradigms, only 1.24% of the worldwide population is using it: any further data providing contexts and insights regarding its use in different application domains may provide data suitable to support the design and implementation of immersive novel experiences (Statista, 2023). This becomes even more evident when taking as reference the country which has the largest amount of VR users, i.e., USA, where 15.96% of the population has experienced VR: a large portion of these users focus on the gaming sector (43%), while a very small percentage (6%) have exploited VR to visualize artistic performances, including concerts (Security, 2022). To this evidence we must add the general reluctance to produce this type of content, driven by the lower perceived authenticity for digital content related to these experiences (Bossey, A., 2022). Yet, the major research contributions on the use of VR are restricted to the area of gaming (Virvou and Katsionis, 2008; Psotka, 2013; Shelstad et al., 2017; Kamińska et al., 2019; Bowman et al., 2022). Although in recent years there has been continuous production of new VR devices, with increasingly complex and novel capabilities, literature still lacks evidence on how consumers respond to VR experiences in the realm of aesthetic perception, for example, in the music domain. Therefore, we still know little about how these technologies impact the enjoyment of artistic performance.

Nowadays an analysis of aesthetic experience cannot neglect updated technologies as they convey art and transform it (Marfia and Matteucci, 2018; Weber-Sabil and Han, 2021). New ‘machineries’ not only facilitate the creation of art but also connects us to the world. Not surprisingly, even artists are now sensitive to the role of technology to such an extent of describing the laptop as “the most intimate instrument that we’ve ever seen” – as stated by the experimental artist Holly Herndon (2019), who collaborated with an artificial neural network trained to sing for her album “Proto”.

From an *experimental* perspective, we intend to exploit the potential of VR technologies as a *methodological* boost to empirical aesthetics: virtual environments provide an excellent compromise between ecological validity and experimental control. Here, we want to compare different devices able to convey an aesthetic-musical experience, including VR devices with varying degrees of immersiveness, in order to investigate their ability to engage, more or less powerfully, the participant with respect to that experience, typically enjoyed in a theater. New generations are certainly more inclined to the use of VR technologies, at the same time they are not accustomed to a context such as the theater and do not autonomously seek “classical” aesthetic-musical experiences, such as the tango concert proposed for our study. That kind of

experience, typically enjoyed in the traditional context of a theater, is closer to an adult-senior audience. We therefore decided to bring the tango concert into virtual reality, to understand whether this new fruition could introduce even a young audience to tango. In this perspective, the adult participants in the Live condition, who are manifestly interested in that type of performance, serve as a baseline for the comparison.

To investigate human aesthetic experience, we need a rethinking of classic laboratory experiments, especially if we consider that “The most enigmatic components of aesthetic experience include inclination to cry, aesthetic rapture, a sense of the sublime, and intense fascination. However, we cannot evoke these ‘hot’ aesthetic emotions in the lab” (Makin, 2017, p. 184). Although empirical aesthetics is often focused on cold evaluation of parts, aesthetic experience is essentially about warm emotional reactions to wholes (Makin, 2017): by capitalizing on emerging technologies, we can overcome traditional reductive approaches. Indeed, by comparing a live experience with other ways provided by the new technologies, the investigation entails also different levels of expectations. Furthermore, VR would also allow us to address inter-individual peculiarities in sensitivity to a specific modality conveying the aesthetic experience at hand: e.g., some individuals could be more likely involved with exhibitions (visual modality), while others with concerts (acoustic modality). The convergence of empirical studies in attesting the effectiveness of VR as a medium for eliciting empathy (Ventura et al., 2020) further encourages us to proceed in this direction.

From a *theoretical* perspective, we are interested in both the emotional and the social dimensions. Thus, in the present work, we addressed the aesthetic emotions evoked in the four conditions (LC, MV, CVR, HVR) through the administration of a validate questionnaire: the Aesthetic Emotions Scale (Aesthemos: Schindler et al., 2017), structured in 21 subscales covering prototypical aesthetic emotions, epistemic emotions, and emotions indicative of amusement. As far as the social dimension is pertained, we investigated the effectiveness of our scenarios in conveying human interactions at hand. Even if social interactions do have a crucial role in aesthetic appreciation, they are frequently neglected when addressing VR aesthetic experiences. Paradoxically, one of the most significant contributions of VR is in its potential to create a sense of “social presence”, that is, the feeling of being and interacting socially within a new environment. Consistently we aimed at detecting the possible feeling of other people’s presence in our scenarios. To assess the feeling of social presence, we administered a revised version of the Networked Minds Measure of Social Presence (Biocca et al., 2001), composed of items focusing on both co-presence and psychological involvement.

These experimental and theoretical perspectives were adopted and applied for a particular use case: evaluating how Virtual Experiences could be put to good use within a musical aesthetic experience. Specifically, in our case we used VR technologies to increase the interest and engagement of a population (young students) which is not interested in attending a certain kind of cultural experience, namely a Tango music concert in a theatre, but that is prone to use Virtual Experience technologies (de la Fuente Prieto et al. 2022; Geng, L. et al 2022; Dwivedi, Y. K. et al. 2022), and comparing them with a strong baseline: passionate adult people, which is usually the target audience for this kind of cultural activities (Meeks, S., et al. 2018).

To clarify, we intended to use LC participants' survey scores as a benchmark to compare the magnitude of interest of passionate adult people with respect to the youngsters that lived instead of Virtual Experiences (MV, CVR, HVR). As an additional contribution, this framework could be adopted with any other kind of aesthetic experience (e.g., ballet, touristic tours).

6.1.1. The present study

The project has been realized thanks to the collaboration with the Teatro Comunale Pavarotti-Freni, the Opera House of Modena (<https://teatrocomunalemodena.it/en/>). Importantly, the Italian city of Modena has recently been awarded the title of UNESCO Creative City for Media Arts. The UNESCO Creative Cities Network has been created in 2004 to promote cooperation with and among cities that have identified creativity as a strategic factor for sustainable urban development: the city of Modena has excelled for its social and cultural projects exploiting artificial intelligence applied to the fields of art and education. The Teatro Comunale Pavarotti-Freni, the most important cultural center of the city, stands out for its inclusion-oriented projects (e.g., CrossOpera, a lyrical opera dedicated to the theme of transcultural integration); consistently, it is trying to initiate immersive concert experiences, taking inspiration from the experimentation led abroad. In Germany, for instance, the Staatstheater Augsburg is working on the vr-theatre@home project to transform the conventional passive role of spectator into a participative position (Weber-Sabil and Han, 2021). For further VR experimentations in the areas of spatial music (acoustic quartet), contemporary opera, rave and rock music, see respectively Bates and Boland (2016); Kallionpää, Chamberlain and Gasselseder (2018); Weinel (2021); Slater and colleagues (2022).

The musical event under our investigation has been “Amarcord d'un Tango,” an open-air concert held on July 14, at 9 p.m., at the “Cortile del Melograno” in Modena, as part of the

“Musiche sotto il Cielo” festival. The concert took shape from the artistic encounter of two Italian virtuosi, playing instruments of mid-19th century: Marco Albonetti (soprano sax) and Daniele Di Bonaventura (bandoneon), accompanied by the “Ensemble dell’Orchestra Filarmonica Italiana.” The concert presented a new recording project created for the English label Chandos Records. Sacred and secular music, folk and tango coexist together in this work, characterized also by Mediterranean inspirations. The melancholy sound of the *bandoneon* blends with modern harmonies and timbres achieved by the strings and soprano saxophone. The bandoneon, named by the German instrument trader Heinrich Band (1821-1860), was originally intended as an instrument for religious and popular music of the time, in contrast to its predecessor (i.e., the German concertina, which had been predominantly used in popular music). Around 1870, German and Italian emigrants and sailors brought the bandoneon to Argentina, where it was adopted into the emerging genre of tango music, a descendant of the earlier milonga.

6.1.2. Experimental conditions: LC, MV, CVR, HVR

The experimental condition *live concert (LC)* consisted of participation in the whole concert. From the video recording of the concert, nine significant minutes were extracted, including the introduction of the artists and the musical performance.

From this recording, we extracted a music video (*music video condition, MV*), and a three-dimensional scenario to be experienced through an app on a smartphone, integrated with adaptive VR glasses (average cost, 20 euros; *google cardboard VR condition, CVR*), or through a professional visor, i.e., a VR headset (average cost, 300 euros; *HTC vive condition, HVR*). The immersive VR interfaces have been developed by the VARLab (<https://site.unibo.it/varlab/en>) by applying protocols that have been already successfully adopted (Morotti et al. 2022). For MV, CVR and HVR conditions, participants watched and listened to nine minutes of the concert; all three pieces of equipment allowed the choice of interface language (Italian or English) and the performance to be paused, re-started, and speeded up or slowed down – even if these actions were not allowed for the experiment.

The reasons behind the choice of nine minutes duration for the video are rooted in literature and further confirmed by a custom survey on the target population who lived the virtual experiences. While our target population from the live condition are used to attending those kinds of events for such a long time, the ideal population for our virtual experiences is composed by youngsters who are not as used to that kind of concert show (Meeks, S., et al.

2018). Indeed, young people are well accustomed to enjoying music videos on the screen, and several studies testify that the average time spent on a video is usually way under the 9 minutes (Nielsen, K. L. 2020, Loh, F. et al. 2022, Yang, S., et al. 2022). Therefore, we considered the 9-minute video of the concert to be a fair trade-off for the youngsters to stay focused and at the same time to provide them with a musical video longer than the ones they are used to. That makes the experience more realistic and closer to their habits, as it was the theatre experience for the live audience population. To further confirm this hypothesis, we here provide some of the results on Media Habits from our follow-up questionnaire called TAMIG (see §6.2.2 and §1.3 of Appendix A) which, among other question items, includes an overview of the student's habits in multimedia and video watching time. It also includes a question about the intention of seeing more than 9 minutes of video after the experiment (further details in §6.2.7).

In particular, the question items related to this peculiar aspect are F5, F7, F8, F9, F10 (see Appendix A §1.3). It is worth noticing that, among the population considered, 96% have seen a video of a concert (Item F5). Considering now the positive answers from Item F5, we extrapolated the minutes value from F7 answers, resulting in an estimate average of 19.6 (21.11) minutes. Considering now the categorical F8 question items, the tendency of the distribution is shifted towards the 10 minutes answer and slightly right skewed (Figure 1). This is general in line with the results obtained in literature (Nielsen, K. L. 2020; Loh, F. et al. 2022; Yang, S., et al. 2022).

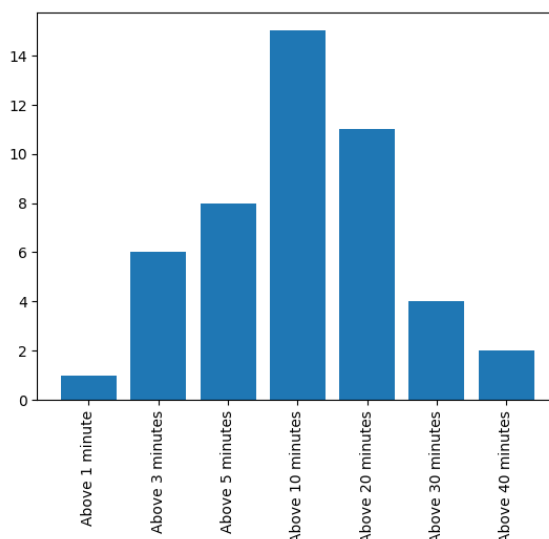


Figure 1. Histograms of F8 question item answers.

Furthermore, item F9 clarifies that the considered population showed uncertainty about watching a video concert longer than 10 minutes, with a mean of 3.2 (1.30). Finally, Item F10 clarified the intentions of watching the target experimental video beyond nine minutes (68% of the population answered No). These results support the chosen duration for the video during the experiment, along with the results already present in the literature (Nielsen, K. L. 2020, Loh, F. et al. 2022, Yang, S., et al. 2022).

After the experiments, for all conditions, two questionnaires (see §6.2.1) were filled out at the end of participation in the experience. The Live conditions were then compared with all other conditions. We point out the main limitations of this comparison: in the live condition, the participants were attending the entire concert; moreover, the participants were the spectators. They had chosen to attend this specific concert, paying for a ticket, and thus evidently appreciating that kind of music. In the other three conditions, the participants experienced only part of the concert; furthermore, the participants were college students, with a lower average age (see §6.2.3 for details), and with (predictably) different musical preferences: their level of motivation for participating in that experience was therefore not the same as the spectators. Students received one college credit for participating in the experiment; spectators received a theater gadget (a pencil). In interpreting the results, we take into account these differences between conditions. Indeed, although they are certainly an obstacle from a methodological perspective, they are inevitable in ecological studies, and further, this allowed us to compare the same experience across distinctive expectations and motivations (thus, aesthetic preferences). For this kind of study, the point is to find the best compromise solution, and to interpret the results cautiously. We believe that methodological difficulties should not inhibit frontier research in relatively unexplored areas.

6.2. Method

6.2.1. Aesthetic Emotions Scale and Networked Minds Measure of Social Presence

To answer our research questions, we needed validated scales able to catch (i) the *aesthetic emotional experience*, to understand whether it was equally effective for MV and VR (considering both the cardboard and HTC Vive devices) compared to LC, and (ii) the *social*

presence, to investigate whether the effectiveness in VR was comparable to that in LC, and significantly higher than that in MV.

(i) Cognitive scientists have tried to implement direct and indirect measures for the variable “*aesthetic emotional experience*”. Recent evidence has shown that the capacity to experience aesthetics, and thus to make appropriate aesthetic judgments, is modulated by daily behavioral habits, as adequate sleep duration, improving also empathic skills (Peretti, Tempesta, Socci, Pino, Mazza, Valenti, De Gennaro, Di Dio, Marchetti and Ferrara, 2018). Indeed, aesthetic perception and aesthetic judgment are not solely "cognitive" processes, but they involve the affective-emotional sphere. Mastandrea, Fagioli and Biasi (2019) have provided a stimulating account of the relationship between aesthetic emotions and physical-psychological well-being: they propose psycho-physiological measures of stress to index aesthetic appreciation. On another side, the behavioral investigation of aesthetic experiences focuses on the conceptualization and measurement of aesthetic self-reported emotions. Schindler and colleagues (2017) have proposed a review of different aesthetic experiences highlighting possible “elicitors” of aesthetic emotions (i.e., arts in the strict sense, but also nature; regarding nature see also Løvoll, Sæther, and Graves, 2020) and have suggested an analysis of existing measures for aesthetic emotions within specific domains (music, literature, film, painting, advertisements, design, and architecture). They finally developed a questionnaire, the Aesthetic Emotions Scale (Aesthemos), structured in 21 subscales covering prototypical aesthetic emotions (e.g., the feeling of beauty, being moved, fascination, and awe), epistemic emotions (e.g., interest and insight), and emotions indicative of amusement (humor and joy), differentiating between the activating (energy and vitality) and the calming (relaxation) effects of aesthetic experiences, and capturing negative emotions that may contribute to aesthetic displeasure. The original version, and the Italian translation, of the Aesthemos-specific scale (Schindler et al. 2017: 42 items in total, 2 for each subscale) is reported in §1.1 of Appendix A (for a semantic profile analysis of aesthetic emotion terms used in the Aesthemos scale see Beermann and colleagues, 2021).

(ii) As stated above, another major factor leading to an effective social VR simulation is the feeling of Social Presence, that is the sense of being with another (Biocca et al., 2001). It refers to the ability of the VR system to create the illusion that the user is inhabiting the virtual environment with someone else. Social presence research, however, suffers from two main flaws: a) the disagreement (and frequent inconsistency) in terminology among researchers, which transfers both into different operationalizations of the construct (Oh et al., 2018) and difficulties in measuring and comparing results; b) the use of different (behavioral

or psychophysiological) markers, not adequately validated. Indirect measures of social presence include those focused on unconscious physiological changes or conscious volitional actions (Slater et al., 2009); a widely used behavioral measure is proximity (e.g., Bailenson et al., 2005). Regarding direct measures, validated questionnaires are often not appropriate for the specific experimental scenario (Biocca et al., 2003): consistently, there are not scales perfectly suitable to measure “social presence” in our four scenarios. In keeping with the suggestions of Sterna and Zibreck (2021), we finally opted to use an adapted version of the validated questionnaire Networked Minds Measure of Social Presence (Biocca et al., 2001). We translated the questionnaire in Italian and slightly re-adapted it by eliminating items not pertinent to the experience of a concert (namely the ones related to behavioral interdependence and mutual assistance). The original version, and the Italian translation and adaptation, of the questionnaire is reported in §1.2 of Appendix A.

Thus, we exploited both the Aesthetic Emotions Scale and the Networked Minds Measure of Social Presence to investigate the aesthetic experience for the examined continuum *music video (MV) – google cardboard VR (CVR) – HTC vive VR (HVR) – live concert (LC)*. For this *continuum* we advance the general predictions that both the feeling of aesthetic emotions and the felt presence of the Other(s) are progressively more powerful. That is, for both questionnaires, the predictions are of the highest scores for LC, gradually lower for VR (as VR allows for the vision of the virtual Other(s) close to the participant: their facial expressions, their possible yawns, etc.); LC should significantly differ from MV (as MV allows for the vision of other spectators only in peripheral vision). MV should result in the poorest aesthetic experience and less social involvement.

The differences between the addressed conditions will necessarily be affected by the differences in the samples tested and their respective motivations and expectations, i.e., for LC we consider the greater motivation and interest respect to MV-CVR-HVR. Thus, the effects will be interpreted also considering this confounding effect.

6.2.2. Follow-up questionnaire: Theater Attendance, Media Habits, Immersiveness and Interest Gain (TAMIG)

To further validate our hypothesis on the populations chosen together with the presented stimuli structure, and to disambiguate whether the results from the previous scales were mainly due to the interest in the specific kind of music genre (i.e., the indirect role of their expectations and motivations) or to the immersive effect of the virtual experiences, we needed a new custom methodological questionnaire. This questionnaire should be able to catch (i) the subject’s

attendance to theatre and (ii) video media, (iii) the *level of immersivity* of the different Virtual Experiences (HVR, MV, CVR) and (iiii) the Interest Gain towards Tango Concert differentiated by the type of Virtual Experiences.

To measure such constructs, we defined a custom questionnaire composed of 4 sub-groups: Theater Attendance, Media Habits, Immersiveness and Interest Gain (Appendix A, §1.3). Theater Attendance aims at evaluating the attendance of subjects at the theatre while Media Habits aims at measuring how long our subjects are used to watching musical videos. Then Immersiveness and Interest Gain aim at evaluating the immersive level of the interface – extrapolating the most meaningful question from the IPQ scale (Schubert, T. W., 2003) while measuring the increase in the interest towards Tango Music in a before/after experiment setting.

This custom questionnaire, renamed as TAMIG, was only furnished to the population which is not usually interested in attending Theater (young students) and was used to further confirm our hypothesis about this population and its relationship with Tango Music Concert, along with the evaluation of Virtual Experiences' tools and how they could increase the engagement around this music genre.

6.2.3. Ethics and Participants

The experiment has been conducted in accordance with the ethical standards laid down in the Declaration of Helsinki and fulfilled the ethical standard procedure recommended by the Italian Association of Psychology (AIP). All procedures were approved by the Ethics Committee of the University of Bologna (Approval number 0159749). For the MV, CVR, and HVR conditions, before starting the experiment, all participants were briefly explained the general objectives of the project and the procedure, then, they signed the written informed consent to participate. For the LC condition, a flyer about the research was distributed before the beginning of the performance. At the end of the concert, volunteers were recruited at the venue. Before filling out the questionnaires, they received a verbal explanation and then signed the informed consent. For all the conditions, participants were aware of the time needed to participate in the experience and the time needed to fill out the questionnaires (i.e., about fifteen minutes).

We tested 70 participants, 10 (*Radbourne, J., 2009*) for the live concert condition (LC: age Mean 56.44; SD 9.03; Females 70%); 20 for the music video condition (MV: age Mean 19.6; SD 1.47; Females 65%); 20 for the immersive condition with the Cardboard (CVR: age Mean 25; SD 6.83; Females 70%); 20 for the immersive condition with the HTC-VIVE (HVR: age Mean 20; SD 1.88; Females 65%). For each virtual experience condition based, 20 was

considered a sufficient large number of participants considered related works (He, L., et al 2018) that demonstrated that 10 is the minimum number of participants to discover 80% of existing interface design problems and so validate it (Salomoni P. et al. 2017; Hwang W. and Salvendy G. 2010; Faulkner 2003; Morotti E. et al. 2022). Most of the participants in the lab conditions informally declared to have no previous experience with VR or 360° video applications.

The mean age in the live condition (LV) is higher than the mean age in the laboratory-tested conditions (MV, CVR, HVR): this is due to our research goal, which consists in evaluating how Virtual Experiences could be put to good use to increase the interest and engagement of a population (young students) which is not interested in attending a certain cultural experience, namely a Tango music concert, but instead is prone to use Virtual Experience technologies (de la Fuente Prieto et al. 2022, Geng, L. et al 2022, Dwivedi, Y. K. et al. 2022), thus checking on their motivations in respect to the former and expectation to the latter.

To strengthen the confirmation of such findings, we included in our TAMIG questionnaire (furnished as a Follow-up experiment) some questions related to the Theater Attendance and Media Habits of our young population (47/60 participants answered the follow-up questionnaire). The experimental mortality for the follow up questionnaire is not of particular concern (13/60). Importantly, participants drop out for the different experimental conditions was comparable, hence, the treatment itself could not be the cause for the noncompliance of research participants (see Ciuk and Yost, 2019). We selected those questions (F1, F2, F3, F5, F6, F11, F12, F13) and reported the results here to support the literature findings.

It is worth noticing that, among the population considered, 68% do not attend theaters. In the remaining 32%, most of the attendees (80%) go just once every 6 months (Item F1-F2) and even a greater percentage (87%) never attend a live Tango Concert (Item F3). Concerning instead the “Virtual experiences”, we specifically focused on the main media used in this work (i.e., video from live concerts) asking about the previous experience with respect to the experimental session, and we did the same for the experience with immersive tools (F5, F6, F11). In particular, 96% of our population had previously seen a video of a concert, while just 28% saw a Tango concert. Finally, around half of the population had previous experience with immersive tools (47%). Among this last sub-population, respectively 41% and 64% have previous experience with Smartphone-based and HTC-Vive virtual Experiences (F12-F13).

As an additional clarification, we asked the subjects who responded negatively to question item F1 why they do not go to the theater (F4). Consistent with our predictions, most of the responses concern a general lack of interest. Moreover, this disinterest is mainly related to a distance with respect to the type of performances offered and that consequently makes this kind of audience (i.e., university students) simply not accustomed to this type of entertainment, as indeed they themselves state in the questionnaire. These responses, therefore, reinforce our choice to test VR technology by offering a Tango concert to a population that is confirmed to be distant from this kind of show (i.e., with low expectations and motivations in respect to this kind of aesthetic experience). Below we report some answers provided by participants at the final debriefing:

1. I am not interested in this kind of entertainment.
2. I don't find it a fun activity.
3. I prefer movies.
4. According to my personal taste and passion, I prefer cinema.
5. The theater shows generally offered in the theater nearest to me are not usually of interest to me or I do not learn about shows that are interesting to me.
6. I have never felt curiosity.
7. It is not something that has never particularly piqued my interest.
8. I don't attend it because my acquaintances are not passionate about it.
9. I am not used to going to the theater.
10. I am not interested in it.
11. Because it doesn't fit my cultural tastes and habits.
12. Probably because of lack of information about it and unfortunately also because of habit.
13. There are no shows that generally interest me.
14. I don't like it.
15. I don't attend the theater because I'm not passionate about it.
16. I simply don't feel involved in many performances, and this causes me boredom.
17. I am not passionate about it.

These comments are consistent with findings in literature showing that the young student population has little experience attending theatre and even less experience attending Tango concerts (de la Fuente Prieto et al. 2022, Geng, L. et al 2022, Dwivedi, Y. K. et al. 2022): this further supports the relevance of our study.

Finally, considering that only the young population lived virtual experiences, we administered the TAMIG questionnaire just to them, while administering the Aesthemos and Social Presence to all the subjects.

6.2.4. Materials and apparatus

For the google cardboard and HTC vive, the 360° video was recorded using the Insta360 Pro2 and post-processed with the Insta360 STITCHER that produced a 2K video. We recorded the concert placing a camera between the stage and the audience, to capture as much detail as possible, without losing focus on the main content, i.e., the musicians on the stage.

Two VR experiences were developed to present such video in both the CVR and HVR conditions. The Game Engine used for developing those experiences was Unity (version 2019.4.39f1). In particular, the CVR application was developed using GoogleVR SDK, while the HVR one using the SteamVR SDK. Both the applications allow to render and reproduce a 360° video on the target devices.

The CVR and HVR settings (3D), differently from the MV (2D), allowed participants to move their heads and explore the space around them while enjoying the show (see Figure 2A and 2B). This is possible considering that both CVR and HVR have the human head rotation 3-degree of freedom devices (i.e., pitch, roll, and yaw). In any of the virtual conditions, no interaction was possible.

The developed CVR application was executed on a Samsung S22 equipped with a Qualcomm SM8450 Snapdragon 8 Gen, 8GB of RAM and 1080 x 2340 pixels. The HVR one was instead executed on an HTC-VIVE Pro (1440 x 1600 resolution) connected to an Alienware Area 51 model. These devices were chosen based on their high-performance to achieve the smoothest video reproduction along with the highest possible resolution.



Figure 2. Figure 2A and 2B show two possible perspectives from which the VR settings permitted participants to watch the concert by turning the head, thus allowing to see the audience.

6.2.5. Assessment model for Aesthemos and Social Presence

The Aesthemos questionnaire presented 42 statements referring to 21 emotion subscales (Schindler et al., 2017): Feeling of beauty; Fascination; Being moved; Awe; Enchantment; Nostalgia; Joy; Humor; Vitality; Energy; Relaxation; Surprise; Interest; Intellectual challenge; Insight; Feeling of ugliness; Boredom; Confusion; Anger; Uneasiness; Sadness.

For the Networked Mind Measure of Social Presence (Biocca et al., 2001), we proposed a shorter version with 30 statements out of 38 of the original one. We eliminated the items on Mutual assistance and Dependent action as inadequate to assess social presence during a concert in a theater, where spectators are not interacting in collaborative actions. The remaining thirty statements can be divided into two groups: Co-presence and Psychological Involvement. The Co-presence group is composed of six statements about Mutual Acquaintance. The Psychological involvement group can be divided in four sub-groups: eight statements on Mutual Attention, six on Behavioral Involvement, four on Mutual Understanding, and six on Empathy.

The subgroups (i.e., constructs) for both the Aesthemos and the Networked Mind Measure of Social Presence are detailed in *Table 1* (§6.3 Data Analysis and Results). For both questionnaires, participants had to rate all the statements on a 5-point Likert scale (1= not at all agree, 5= very much agree); they could write comments or suggestions at the end of the questionnaire.

6.2.6. Assessment model for TAMIG

The TAMIG presented 19 questions referring to 4 constructs (2 for Theater Attendance, 11 for Media Habits and 6 for Immersiveness and Interest Gain). For evaluating the immersiveness, we proposed a shorter version of the original IPQ scale (Schubert, T. W., 2003), with three statements of the fourteen out. All the other questions were custom-made; however, they follow the best-known practices for designing questionnaires (Krosnick, J. A., 2018). We adopted different type of scales, based on the question item and the sub-group: 5-point Likert scale, Categorical Scale, Ordinal Scale, Open Question and Yes/No questions (see §1.3 of Appendix A for the complete details).

6.2.7. Procedure

Below, we explain in detail the procedures for each of the four experimental conditions.

6.2.7.1. Live concert.

The LC condition was executed at the Teatro Comunale “Pavarotti-Freni” in Modena, on the concert “Amarcord d’un Tango” (on July 14th, 2022, at 9 p.m.). The event took place outdoors, in the theatre courtyard. At the end of the concert, we asked volunteers to fill in a hard copy of both the questionnaires, while sitting at the station we placed in the theatre foyer. As it was late at night (about 11 p.m.), most spectators were in a hurry to get back home, therefore not available to participate.

For the other three conditions we used a nine-minute 360° video of the concerts. Participants were tested at the Virtual and Augmented Reality Lab (VARLAB) of the University of Bologna. All the tests took place in a silent room with no other person present but the experimenter and the participant. After each of the three experiences, participants filled out both questionnaires presented on mobile phone through the Qualtrics platform (Qualtrics, Provo, UT).

6.2.7.2. HTC vive.

The HVR condition consented participants a full immersive virtual reality experience by giving the opportunity to have a 360° visual perspective of the concert context by wearing the HTC-Vive. This kind of headset was a professional device, the use of which requires specific IT expertise. None of the participants had any previous experience with this device. Before the test, they were instructed about the kind of experience: a 9-minute video-concert in a VR immersive environment in which they could turn themselves around and move their head up and down, left or right, as they preferred, changing the scenario accordingly.

6.2.7.3. Google cardboard.

In the case of the CVR setting, we used a Samsung S22 device, chosen for the high quality of the display. The smartphone was inserted into the simplest version of a cardboard (box paper with two lenses). Unlike the HTC-Vive, this device was not provided with custom headphones to listen to the music in an immersive way. We provided participants with Bluetooth wireless headphones. Despite the need for external headphones, cardboard is a cheap device, quite easy to afford, through which anyone can try a first basic VR experience at home. Also, for this condition, none of the participants reported previous experience with the device at hand. Before starting, participants were informed about the kind of experience.

6.2.7.4. Music video.

For the MV condition, participants watched the concert while sitting in front of a 4k PC screen, wearing the same headphones used for the CVR condition. This condition was conceived as to replicate the well-known experience of watching a concert at home on YouTube, well known to all our participants. Due to the features of the 360° camera, the video was shown by an unusual perspective: each participant had a between-the-audience point of view, allowing for a simultaneous watching of both the musicians (i.e., the concert, at the middle of the screen) and part of audience (on the sides), as if she was sitting in the middle of the scene. We introduced this novelty (i.e., making visible a part of the audience) to make the 2D condition comparable to the other ones, and thus to make meaningful our questions on social presence. Participants were instructed about the 2D condition, for which they could only watch the video: any head movements were not followed by any change in the scenario.

6.3. Data Analysis and Results

In this section we describe the analyses carried out on the data collected for both the questionnaires. Please note that all the analyses were performed using out-of-the-box and adjusted functions provided in the Python libraries ‘Pingouin, Statsmodels, Scipy’. Overall, there were only eleven empty cells (due to non-response of participants in the first experimental session). To avoid both discarding the questionnaire questions and affecting the distribution of the data, in the pre-processing for each subject we replaced the missing value with the means of the distribution for the related item.

6.3.1. Reliability Test

The collected data has undergone a reliability check to test for internal consistency and validate our research. For both the questionnaires, we computed the widely accepted Cronbach’s alpha index for each sub-group (i.e., construct). Each sub-group was considered consistent if the Cronbach’s alpha index was ≥ 0.70 (as indicated by Taber, 2018). Results are reported in Table 1. For what concern the Assessment model for TAMIG, we subjected the Immersiveness and Interest Gain, because they were the only subgroups measuring a construct.

While twelve out of twenty-one constructs of the Aesthemos passed the internal consistency test (in bold in Table 1), the Social Presence scale presented only one out of five consistent subgroups of answers (Psychological Involvement: Behavioral involvement, in bold in Table 1). In the following analysis, for each questionnaire we will consider only those subgroups with acceptable Cronbach's alpha index.

Scale	Sub-groups	Questions	Cronbach Alpha	Acceptable
Aesthemos	1 Feeling of beauty - liking	E1-E6	0.87	Yes
	2 Fascination	E7-E34	0.81	Yes
	3 Being moved	E14-E36	0.57	No
	4 Awe	E31-E40	-0.13	No
	5 Enchantment	E8-E18	0.81	Yes
	6 Nostalgia	E26-E28	0.59	No
	7 Joy	E3-E39	0.79	Yes
	8 Humor	E22-E42	0.92	Yes
	9 Vitality	E9-E32	0.76	Yes
	10 Energy	E16-E41	0.59	No
	11 Relaxation	E4-E20	0.86	Yes
	12 Surprise	E11-E29	0.21	No
	13 Interest	E5-E38	0.8	Yes
	14 Intellectual challenge	E2-E10	0.01	No
	15 Insight	E13-E21	0.73	Yes
	16 Feeling of ugliness	E12-E35	0.65	No
	17 Boredom	E19-E33	0.76	Yes
	18 Confusion	E24-E37	0.54	No
	19 Anger	E17-E25	0.87	Yes
	20 Uneasiness	E27-E30	0.68	No
	21 Sadness	E15-E23	0.78	Yes
Social Presence	a Co-Presence: Mutual Acquaintance	P1-P2-P3-P4-P5-P6	0.43	No
	b Psychological Involvement: Mutual Attention	P7-P8-P9-P10-P11-P12-P13-P14	0.45	No
	c Psychological Involvement: Behavioral Engagement	P25-P26-P27-P28-P29-P30	0.81	Yes
	d Psychological Involvement: Mutual Understanding	P15-P16-P17-P18	0.58	No
	c Psychological Involvement: Empathy	P19-P20-P21-P22-P23-P24	0.01	No
TAMIG	Interest Gain	F14-F15	0.87	Yes
	Immersiveness	F17-F18-F19	0.77	Yes

Table 1: Cronbach's alpha index for all the considered sub-groups (i.e., constructs) of the three questionnaires. Twelve out of twenty-one constructs of the Aesthemos (in bold) passed the internal consistency test (in bold); one out of five constructs of the Social Presence scale (in bold) passed the same test; The Immersiveness and Interest Gain in TAMIG passed the same test.

6.3.2. Data Visualization and description of the trends

In this section we report the overall results only for acceptable constructs, plotting them in three different figures. Each figure shows mean scores (Likert scale), and standard deviation reported as error bars.

Participants' scores for the Aesthemos, aggregated for each subgroup, are reported in Figure 3 (first six subgroups) and Figure 4 (last six subgroups). For the constructs shown in *Figure 3* (Feeling of beauty – liking; Fascination; Enchantment; Joy; Humor; Vitality) there is a general agreement on the superiority of the Live condition over all others (MV, CVR, HVR). However, HVR seems to be preferred to CVR and MV for the constructs Fascination, Enchantment, and Joy. For the constructs shown in *Figure 4* (Relaxation; Interest; Insight; Boredom; Anger; Sadness), the advantage of the LC condition over all the others is no longer evident. In particular, the plot shows that Interest is similar for LC and HVR, and greater than CVR and MV; Boredom is more pronounced for the MV condition than for the other three scenarios, especially when compared to LC. For the constructs Anger and Sadness, the values are relatively consistent and similar for the different experimental conditions.

Figure 5 shows the mean scores, and associated error bars, for the only construct of the Social Presence scale that passed the internal consistency test, i.e., Psychological Involvement: Behavioral Engagement. The graph shows high variability for all conditions: it is not possible to detect any advantage of one condition over the others in relation to the perceived behavioral involvement in the four experiences.

Figure 6 instead, reports the mean scores, and associated error bars, for Immersiveness. The graph shows a clear tendency of Immersiveness for the HVR with respect to the other devices (He, L., et al 2018), even considering the variability.

Finally, *Figure 7* shows the same statistics for the Interest Gain. It is interesting to note that in each condition an interest gain was verified. On the same line, it is worth noticing that HVR was the experience where the relative interest gain was higher with respect to the other virtual conditions.

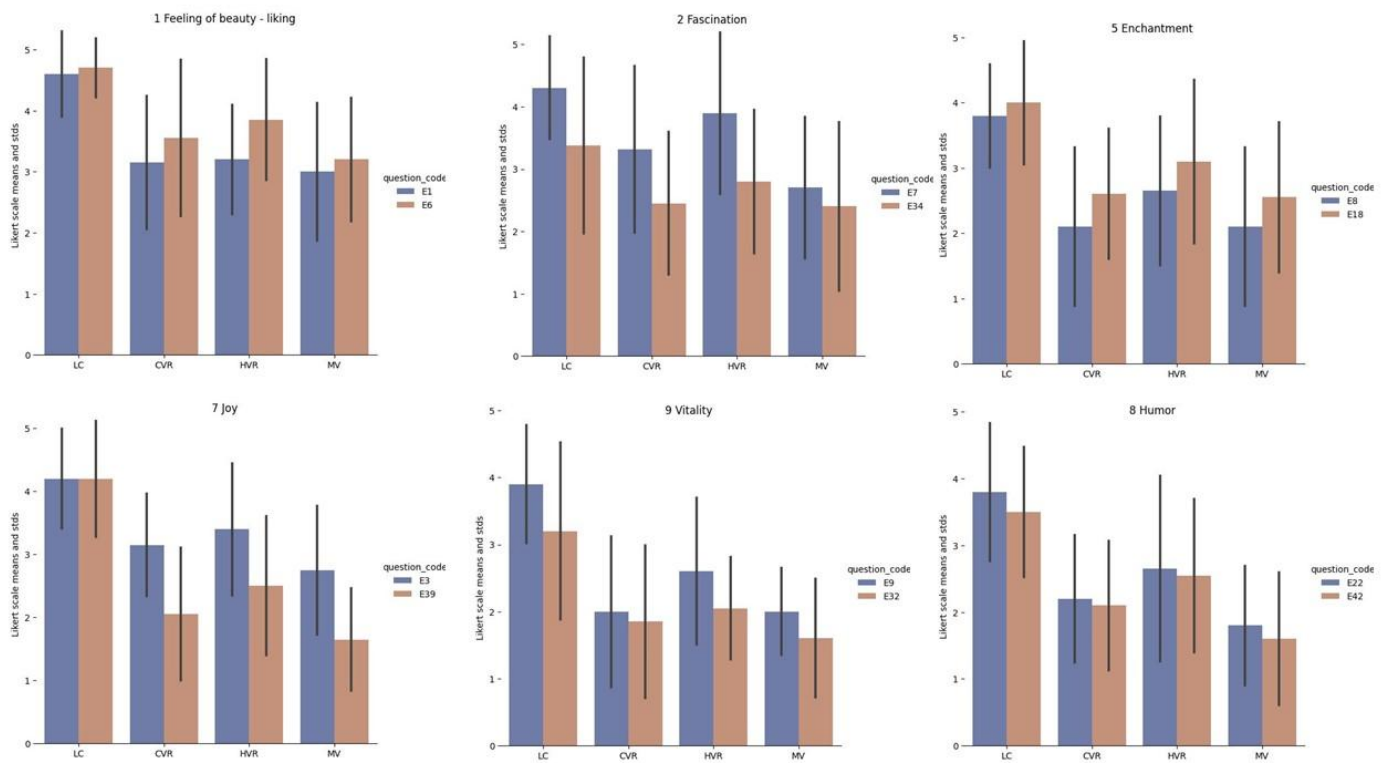


Figure 3. Histograms of first six sub-groups of the Emotional Scale: 1 Feeling of beauty – liking; 2 Fascination; 5 Enchantment; 7 Joy; 8 Humor; 9 Vitality. Error bars represent the standard deviation.

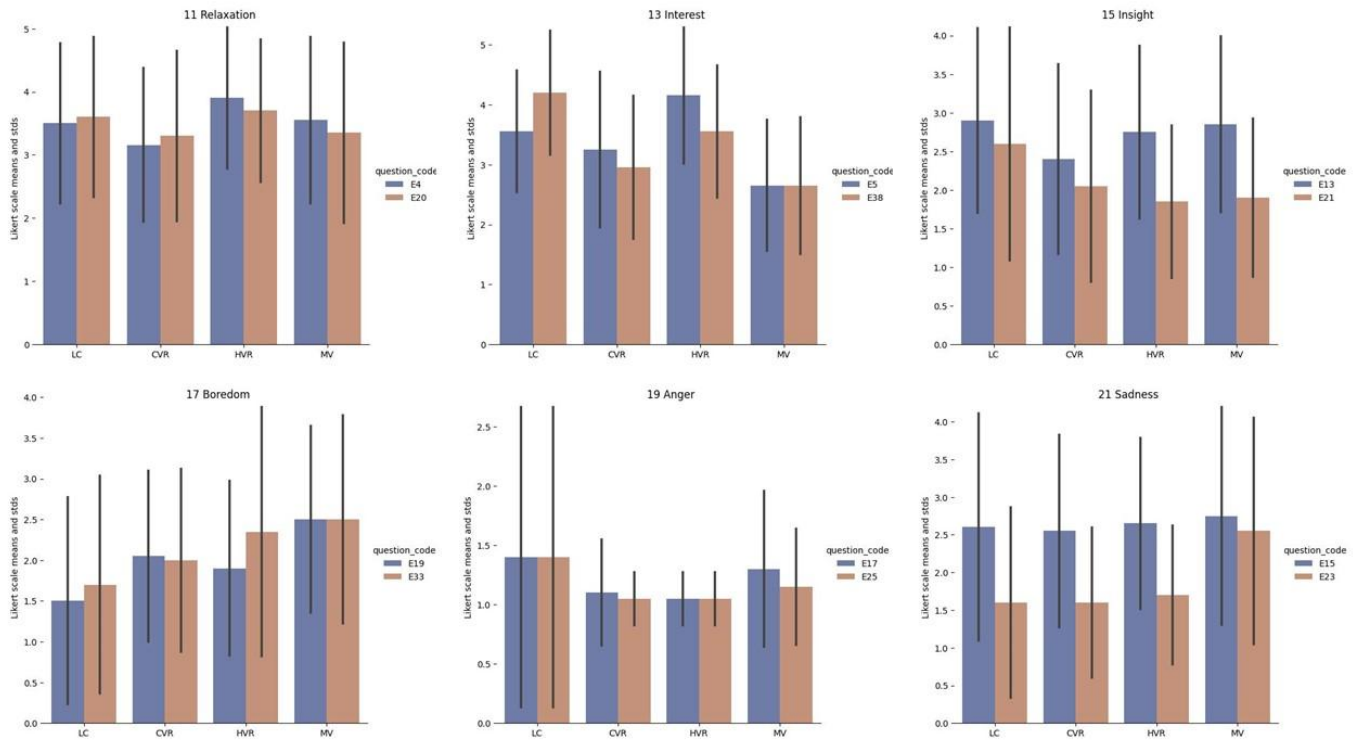


Figure 4. Histograms of the second six sub-groups of the Emotional Scale: 11 Relaxation; 13 Interest; 15 Insight; 17 Boredom; 19 Anger; 21 Sadness. Error bars represent the standard deviation.

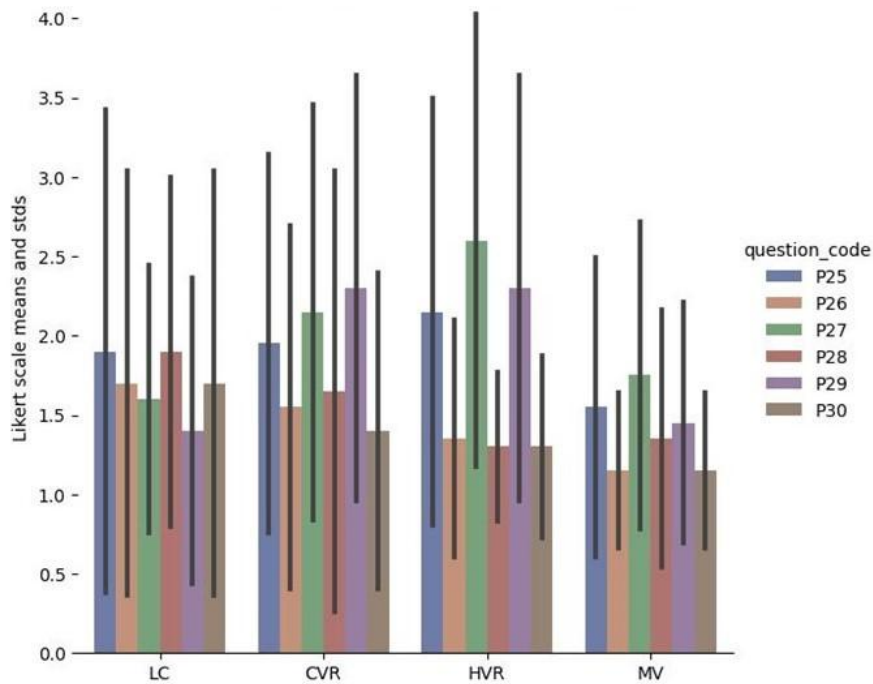


Figure 5. Histograms of the consistent sub-group for the Social Presence Scale: *c* Psychological Involvement: Behavioral Engagement. Error bars represent the standard deviation.

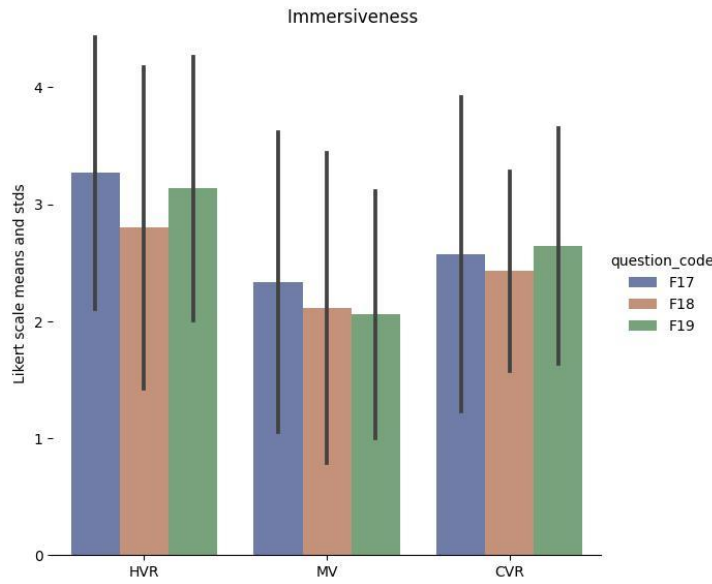


Figure 6. Histograms of the consistent sub-group for the TAMIG: Immersiveness. Error bars represent the standard deviation.

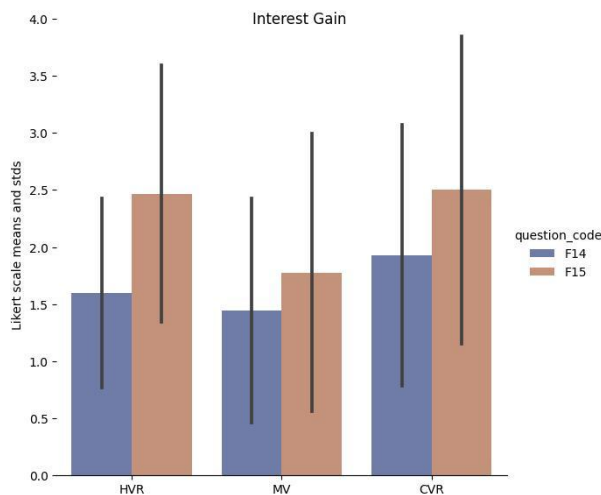


Figure 7. Histograms of the consistent sub-group for the TAMIG: Interest Gain. Error bars represent the standard deviation.

6.3.3. Adjusted Wald-Confidence Interval test & Wilcoxon signed-rank test

In this section we perform statistical analyses on the obtained scores to verify (only for the constructs that passed the internal consistency test) any significant differences among the four conditions, namely LC, MV, CVR and HVR.

Following the guidelines of Agresti and Caffo (2000), we performed an Adjusted Wald-Confidence Interval test: this statistical test allows to check if the difference between two proportions is significant and how large the difference is. We selected this specific statistical

test as we had four conditions and a low number of samples for each of them (Sauro and Lewis, 2016).

We considered a confidence level of 95%, thus the two-sided z critical value for the test corresponded to 1.96. To adapt our data for the specific test, we binarize the Likert-scale answers with a threshold of 4: ≥ 4 Likert scale answers were converted to 1, the lower to 0. Considering that the Adjusted-Wald Confidence Interval test compares two proportions, we proceeded comparing, two by two, all the scores got in the different conditions for each subgroup of questions of the two questionnaires.

Thus, as an example, for the construct “X”, composed by questions Ey – Ez, we run a comparison test between each possible pairing of our four conditions (LC, CVR, HCV, MV). Then we accumulated, for each question in each construct (subgroup), just the pairings that provided positive Wald Adjusted Difference and a lower confidence interval greater than zero – meaning that the considered condition (e.g., LC) does have a higher score than the others (e.g., MC, CVR, HVR) for the question under examination (e.g., Ez). In this way we could find a difference in proportions valid for the entire construct (instead of for a single question within the construct-subgroup).

Conversely, for the Interest Gain of the TAMIG we considered a different test since this construct aims at evaluating the relative gain in interest towards Tango Music in a pre-post experimental scenario. Considering that our sample population is less than 30 and that we are dealing with Likert Scale scores, we decided to adopt a non-parametric test, namely the Wilcoxon signed-rank test (Woolson, R. F., 2007). In practice, this tests the null hypothesis that two related paired samples come from the same distribution, and it tests whether the distribution of the differences between two paired sequences is symmetric about zero. It is very appropriate for a repeated measure design where the same subjects are evaluated under two different conditions, and it is the non-parametric equivalent of the parametric paired t -test. In our case, the two different conditions are “before” and “after” the virtual experience. In our specific case we have a one-sided test with a confidence level of 95%, where the null hypothesis indicates whether the distribution underlying the difference between the before and after interest in Tango Music Concert is stochastically greater than a distribution symmetric about zero.

6.3.4 Significant Results for Aesthemos and Social Presence

6.3.4.1. *Aesthemos*.

Concerning the Aesthemos Emotional Scale, twelve constructs passed the Cronbach's Internal Consistency Test: 4 of these 12 sub-groups (namely: Relaxation, Insight, Boredom, Anger) did not show any significant results for the Adjusted-Wald Confidence Interval test. Instead, for the constructs Fascination and Sadness we found significant results but without agreement between the two items, thus, we will discuss the results only briefly. More interestingly, the constructs for which we found significant results and agreement between the items are the following (6/12): Feeling of beauty, Enchantment, Joy, Humor, Vitality, Interest.

All significant comparisons for the Aesthemos (including Fascination and Sadness, in *italics*) are shown in *Table 2*, organized by construct and question-item, and reporting the Wald inferior bound, Wald difference, Wald max bound and Mixed representation.

Live Concert (LC) was found to be the most effective condition in activating aesthetic emotions since this condition turned out to be superior for 5 of the 7 constructs (acceptable wald-difference) in at least one comparison with all the other three conditions (all of the above mentioned except Interest and Sadness).

More specifically, LC was found to be significantly more activating (i.e., more enchanting, joyous, and amusing) when compared to Music Video (MV) and VR experience with google cardboard (CVR), but not when compared to VR experience with the HTC-Vive (HRV). Thus, even if the live condition remains the best way to enjoy a music concert, the difference with the same experience lived through the HCT-Vive headset is not meaningful. This suggests that the HVR is the "artificial experience" that can offer the spectator an experience more like the "real-live one". The only construct for which LC significantly differed from all the other conditions (thus also from HVR) is the Feeling of beauty: the LC was the most liked experience.

Looking at the construct Interest, the HVR condition resulted significantly more interesting than MV (underlined in Table 2). To the best of our knowledge, this is the first empirical evidence of a major interest for *musical* aesthetic experiences (i.e., experiences for which the acoustic component, and not the visual or social ones, should be predominant) when experienced in VR (HVR) than on a computer screen (e.g., on YouTube or Twitch). Moreover, for one of the items of the construct Interest (namely the E5: "It made me curious"), the HVR condition was found to be superior not only to MV, but also to CVR and even to LC. (This

item is also the only one for which LC resulted significantly lower with respect to another of the three tested conditions).

Overall, our results are consistent in supporting a clear advantage for the Live Concert. Nevertheless, they also emphasize that the experience with the HTC-Vive device is, immediately following, the most powerful in evoking aesthetic emotions, thus better than those generated with a device such as a computer (MV) or a google cardboard (CVR).

This advantage is further confirmed if we look also at the scores for the item E31, “I found it sublime”, of the Fascination construct (for the complementary item, E34, no acceptable wald differences were found) and at the scores for the item E23, “It made me sad”, of the Sadness construct (for the complementary item, E15, no acceptable wald differences were found). From this more comprehensive outlook HVR emerges as significantly “more sublime” than MV and CVR, and MV appears as an experience significantly “sadder” than both HVR and CVR.

Construct	Quest.	Comparisons	Wald inferior bound	Wald difference	Wald max bound	Mixed representation
1 Feeling of beauty – liking	E1	LC > CVR	0.18121	0.47243	0.76365	0.18 0.47 0.76
		LC > HVR	0.18121	0.47243	0.76365	0.18 0.47 0.76
		LC > MV	0.23125	0.51805	0.80485	0.23 0.52 0.8
	E6	LC > CVR	0.15931	0.41946	0.67961	0.16 0.42 0.68
		LC > HVR	0.02884	0.2826	0.53636	0.03 0.28 0.54
		LC > MV	0.20563	0.46508	0.72453	0.21 0.47 0.72
5 Enchantment	E8	LC > CVR	0.08037	0.40324	0.72611	0.08 0.4 0.73
		LC > HVR	0.08037	0.40324	0.72611	0.08 0.4 0.73
		LC > MV	0.13458	0.44886	0.76314	0.13 0.45 0.76
	E18	LC > CVR	0.02749	0.35762	0.68775	0.03 0.36 0.69
		LC > MV	0.02749	0.35762	0.68775	0.03 0.36 0.69
7 Joy	E3	LC > CVR	0.1718	0.47978	0.78776	0.17 0.48 0.79
		LC > MV	0.1718	0.47978	0.78776	0.17 0.48 0.79
	E39	LC > CVR	0.22949	0.53275	0.83601	0.23 0.53 0.84
		LC > HVR	0.12185	0.44151	0.76117	0.12 0.44 0.76
		LC > MV	0.28551	0.57837	0.87123	0.29 0.58 0.87
8 Humor	E22	LC > CVR	0.13458	0.44886	0.76314	0.13 0.45 0.76
		LC > MV	0.19022	0.49448	0.79874	0.19 0.49 0.8
		<u>HVR > MV</u>	0.03962	0.27372	0.50782	0.04 0.27 0.51
	E42	LC > CVR	0.13458	0.44886	0.76314	0.13 0.45 0.76
		LC > MV	0.13458	0.44886	0.76314	0.13 0.45 0.76

9 Vitality	E9	LC > CVR	0.33269	0.61664	0.90059	0.33 0.62 0.9
		LC > HVR	0.224	0.5254	0.8268	0.22 0.53 0.83
		LC > MV	0.44808	0.70788	0.96768	0.45 0.71 0.97
	E32	<u>LC > HVR</u>	0.02243	0.32669	0.63095	0.02 0.33 0.63
		<u>LC > HVR</u>	0.02243	0.32669	0.63095	0.02 0.33 0.63
13 Interest	E5	<u>CVR > MV</u>	0.05523	0.31934	0.58345	0.06 0.32 0.58
		<u>HVR > LC</u>	0.02749	0.35762	0.68775	0.03 0.36 0.69
		<u>HVR > CVR</u>	0.00078	0.27372	0.54666	0.0 0.27 0.55
		HVR > MV	0.35511	0.59307	0.83103	0.36 0.59 0.83
	E38	LC > CVR	0.07123	0.38854	0.70585	0.07 0.39 0.71
		LC > MV	0.224	0.5254	0.8268	0.22 0.53 0.83
		<u>HVR > MV</u>	0.04707	0.31934	0.59161	0.05 0.32 0.59
2 Fascination	E31	LC > CVR	0.02275	0.34292	0.66309	0.02 0.34 0.66
		LC > MV	0.224	0.5254	0.8268	0.22 0.53 0.83
		HVR > CVR	0.04176	0.31934	0.59692	0.04 0.32 0.6
		HVR > MV	0.24613	0.50182	0.75751	0.25 0.5 0.76
21 Sadness	E23	MV > CVR	0.08138	0.31934	0.5573	0.08 0.32 0.56
		MV > HVR	0.08138	0.31934	0.5573	0.08 0.32 0.56

Table 2: the Table reports all significant comparisons for the Aesthemos (including Fascination and Sadness, in italics), organized by construct and question, and reporting the Wald inferior bound, Wald difference, Wald max bound and Mixed representation. The conditions of advantage for HVR (for Humor and Interest constructs) are underlined.

6.3.4.2. Social Presence

Concerning the Networked Minds Measure of Social Presence, as stated above, only one construct (i.e., sub-group of items) passed the Cronbach’s internal consistency test, namely the *Psychological Involvement: Behavioral Engagement* one. However, no significant difference between the four conditions has been found for this construct.

6.3.5. Significant Results for TAMIG

6.3.5.1. Immersiveness

Concerning the immersiveness in the TAMIG questionnaire, no significant difference between the four conditions has been found for this construct with the Agresti-Caffo test.

6.3.5.2. Interest Gain

As mentioned, the Interest Gain question items (F14, F15) were subjected to the Wilcoxon signed-rank test for the different virtual experiences. In all the conditions, the test rejects the null hypothesis, meaning that the interest in Tango Music concerts has risen in every condition. However, the statistical effect was higher in HVR with respect to the other two.

Construct	Comparisons	Wilcoxon Stats	Wilcoxon P-Value
Interest Gain	HVR	45	0.003
	MV	24.5	0.029
	CVR	21	0.012

Table 3: the Table reports the significant results obtained by subjecting items F14 AND F15 to the Wilcoxon signed-rank test. Even if the measured differences were all statistically significant, the HVR condition provided the strongest effect.

6.3.6. Qualitative analysis

To further analyze and support the previously introduced results, we integrate a qualitative analysis based on two different “thinking aloud” (Lewis, C., 1982) experimental sessions to catch the pros and cons of the Virtual Experiences and the Target Music genre. We here report some of the answers that participants gave in the final section of the questionnaires, where they were free to write any spontaneous comment. The answers can be summarized in the following two arguments:

- (a) The specific music genre we selected (i.e., Tango) is disliked by the youth audience. Despite a general interest in music concerts, participants stated that they did not like the video’s music genre, thus presumably they were less involved or less affected by the experience itself. For example, participant #62 stated: *“I really enjoy music and the experience of live concerts, however, the genre played is not among my favorites. As a result, it did not particularly stimulate or impress me. If it had been another genre, and if there had been a person singing, it would not have left me so indifferent, and I would have been more involved. I do not consider it an unpleasant experience though; I could never consider the music as such”*.

- (b) The weaker immersive effect and lower usability of the cardboard compared with the HTC condition. Indeed, sometimes the intensity of the experience has been affected by some of the google cardboard's characteristics, being a less immersive and comfortable tool compared with the HTC. For example, participant #15 stated: *"It was a fairly intense experience, partly adversely affected (at the level of physical stress) by the way the concert was enjoyed, which I found very heavy on the eyes"*.

The second analysis concerns participants' responses to the TAMIG questionnaire about the reason why they do not go to theatre (item F4). The answers can be summarized in the following three arguments:

- a) Lack of interest in theatre: most of the participants who do not go to theatre affirmed that their choice is related to a general disinterest toward this kind of entertainment which is not fun for them, and it differs from their personal knowledge and preferences. Here are some examples: *"I don't find it a fun activity"*; *"I am not passionate about it"*; *"there are no shows that generally interest me"*; *"I have never felt the curiosity"*; *"It is not something that has ever particularly piqued my interest"* ...
- b) Absence of habit in going to the theater: several participants stated that they just never had this kind of habit. Some responses show that this is due to the distance from their cultural interest, and for the fact that none of their acquaintances are used to go to theater, as for example in this answer: *"I don't attend it because my acquaintances are not fond of it, and I wouldn't know who to go with"* ...
- c) Financial reasons: some participants said they cannot afford to go to the theater.

Undoubtedly, all the arguments discussed above give strength to some of the choices we made to pursue our goal of inquiry. Indeed, to test the immersive tools' potential with our lab's participants (namely, university students), we needed to propose a musical genre far from their standards. Moreover, the effect that we were looking for (i.e., to augment the interest toward a musical aesthetic experience such as a Tango concert in theatre, lived through VR tools) had to be experimented on a kind of audience that lack any initial interest in theatre. The responses that we collected from all questionnaires (the ones filled during the experimental session and the TAMIG) converge, showing that difference between the LC's participants and

the lab participants is not to be considered as a limit of the study, but rather a methodological choice that allowed for testing this aesthetic experience on participants with different level of motivation and expectations in respect to the kind of music genre and the modality through which it was experienced, and enabling us to use LC participants' survey scores as a benchmark to compare the magnitude of interest. Finally, the results obtained in the different scales considered in this work highlight the role of virtual experience in increasing engagement towards Tango music concerts.

6.4. Discussion

6.4.1. Aesthemos

For the Aesthemos, analyses showed that the only construct for which LC significantly differed from all the other conditions is the Feeling of beauty. However, the greater fascination we found for LC than for HVR may be biased by the important difference between the samples in LC vs. HVR conditions. As highlighted above, participants in LC condition were people who had purposely chosen to attend the specific show at the theatre, meaning that they were already motivated to participate at such kind of concert. Differently, students who came to the lab for the experiment had not autonomously taken such a choice: even though the experience for them lasted only nine minutes, it was not greatly appreciated. Additionally, the difference in the mean age of the two samples (LC: 56 vs. HVR: 20 years old) lets us predict discrepancies in the musical preferences of the two groups (theatre's audience for the LC condition vs. college students for the other lab-conditions). Final comments reported by the HVR participants attested that tango is not particularly liked as music genre by younger generations (e.g., "I really enjoy music and the experience of live concerts, however, the genre played is not among my favorites. As a result, the concert did not particularly stimulate or impress me. With another genre, or in case of a person singing, I would have been more involved, not indifferent"). We reasonably suppose that this confound partially obscures far more important effects of the HVR condition: the integration of the results of the statistical analysis with the comments made by the participants lead us to speculate that the experience in the virtual environment (HVR) is actually powerful in evoking aesthetic emotions (or at least, more than attested by the analysis of the collected scores), much like the live condition. A counterevidence would consist in the (future) replication of this study for which we would choose a musical genre, and thus a concert, that young people could appreciate (given the greater simplicity to test in the laboratory setting

young college students rather than testing in lab older participants with the same musical, i.e., tango).

6.4.2. Social Presence

We questioned the absence of significant results. The Networked Minds Measure of Social Presence questionnaire (Biocca et al 2001) is aimed at providing a metric to measure the degree to which individuals feel interconnected to each other through networked telecommunication interfaces. Even in the conditions with a digital interface (MV, CVR, HVR), for which high and relatively consistent scores might be expected, the experimenter never provided any explicit reference to the Other(s), nor a conceivable interconnection with the Other(s), nor a possible enrichment of the aesthetic experience through the integration of the social component.

The social enrichment of the musical experience could be a factor that comes into play only at a later stage, that is, after the subject has acquired a complete knowledge of the event-scenario, and of the device, on its own. Moreover, for the concert experience, for which the presence of the Other(s) is not “necessary,” it is possible that the administered questionnaire (originally designed for other contexts) is less sensitive.

Another possible explanation for the lack of significant results for the social presence may be sought in the choices made for audio-video recording of the concert – that we used to build the MV, CVR and HVR experiences. One of the concerns in the recording was the position of the camera: the concert was outdoors, the stage where the musicians played was not close to the audience (as is generally the case in theaters, indoors). To get a good view of the stage, the camera had to be placed in the space between the stage and the front row of the audience. Participants in VR conditions by turning their heads could have a full view of the other spectators, but they could not have spectators’ perspective (i.e., the perspective participants would have as sat audience). This confounding perspective might have negatively affected the perception of the Other(s) in the CV, MVR and HVR conditions.

For the future adaptations of this experimental paradigm, we critically suggest to take into consideration all the weaknesses discussed above, together with the possibility of selecting a different validated questionnaire, that is more sensitive to social aspects in the specific examined context, and of supplementing these surveys with psychophysiological measurements.

6.4.3. Immersiveness and Interest Gain

On one side, the TAMIG analyses showed that the Interest Gain is stronger in HVR with respect to the other virtual conditions even if all the conditions passed the test. This was somewhat expected, considering that the majority of the population never saw a Tango Concert video, and this has certainly increased the curiosity about it, appealing to their expectations with the surprise of novelty. However, this result is in line with the hypothesis of our study: the HTC-Vive is the best device to increase interest and engagement around the target music genre.

On the other hand, analyses on Immersiveness didn't provide any significant difference. However, the first experience with HTC-VIVE and the experience of living a full-immersive VR with a headset could have biased the results. Indeed, less than half of our population had virtual experiences before the experiment which might have influenced their expectations and motivations. Even considering this, the scores of immersiveness were higher than the other two conditions.

6.5. Conclusions

The present work shows the preliminary results of a pioneering project aimed at comparing the aesthetic experience of a musical concert lived in different contexts for which the audience's perceived presence is modulated in a continuum ranging from a live concert to a music video, passing through immersive artificial environments. The project has been inspired by the recent experimentation by Staatstheater Augsburg (in Germany, Weber-Sabil and Han, 2021) aimed at rethinking art and its places; it has been conducted thanks to the collaboration with the Opera House of Modena (Teatro Comunale Pavarotti-Freni, Italy). This new line of research involves psychologists, computer scientists, philosophers, and artists.

From an *experimental* perspective, we exploited the potential of VR technologies as *methodological* boost to empirical aesthetics; from a *theoretical* perspective, we addressed the aesthetic emotions aroused by VR experiences, through the Aesthetic Emotions Scale (Aesthemos, Schindler et al, 2017). In addition to the more traditional investigation of VR pleasantness, we wanted to also address the VR effectiveness in rendering the social aspects of immersive (musical) experiences. To measure the social presence, we used a revised version of the Networked Minds Measure of Social Presence (Biocca et al., 2001), composed by items focusing on both co-presence and psychological involvement.

Thus, we assessed both the *Aesthetic Emotions* and the *Social Presence* in contexts with different levels of immersivity distributed in the proposed continuum: at one extreme the live concert, at the other extreme the traditional music video, in between the experience in an immersive virtual reality environment (CVR and HVR); while in the live condition both performers and audience were present, in the other conditions their presence was only evoked.

Live Concert was the most liked experience, as attested by the analysis of the Aesthemos' construct *Feeling of beauty – liking*. Interestingly, it was found to be also the most enchanting, joyous, and amusing experience, but only if compared to Music Video and VR experience with google cardboard, not when compared to the VR intensely immersive experience with the HTC vive. This last finding suggests that, at least for the constructs of Enchantment, Joy, and Humor, the proposed "artificial" HVR experience was not significantly different from the "real" one.

Crucially, for the *Interest* construct we no longer find the superiority of the Live condition, but a clear preference for the HTC live one. At the best of our knowledge, this is the first empirical evidence of a major interest for musical aesthetic experiences (i.e., experiences for which the acoustic component, and not the visual or social ones, should be predominant) when experienced in VR (HVR) than on a computer screen (e.g., on YouTube or Twitch).

These findings are even more relevant when taking into account some of the confounds of our work, which we could not avoid in order to keep the study ecological but at the same time allowed us for testing aesthetic emotions in relation to motivations and expectations: the Live condition sample consisted of participants who were highly motivated toward that concert – they paid for a ticket to participate that specific show. The scores they gave to the items of the various constructs of the Aesthemos were necessarily biased toward high values. Conversely, the samples for the MV, CVR, and HVR conditions were composed of college students who were much younger, had different preferences in music (confirmed also by the final comments reported on the questionnaire, where most of them explicitly expressed their limited appreciation toward that genre of music, and thus for that type of experience), and had been recruited from class to participate in the laboratory experiment. This fact, although it might have obscured possible effects of the non-live conditions, permits to see how the same stimulus modulates emotions when the initial motivations and expectations differ, and its effects in relation to different context and modalities of a musical aesthetic experience.

Concerning the Social Presence, no significant findings were found. Therefore, we reasoned on the adopted scale, the Networked Minds Measure of Social Presence, actually developed to measure the degree to which individuals feel interconnected to each other through

networked telecommunication interfaces. The presence of the Other(s) may have been poorly felt in these different experiences; another (plausible) explanation for the lack of significant effects may lie in the low sensitivity of the chosen questionnaire in detecting the feeling of social presence in the specific scenario we investigated, namely a musical experience of a tango concert. Consistently for future developments of this project we would consider the possibility of selecting a different validated questionnaire and of supplementing the surveys with psychophysiological measurements indexing the feeling of being socially immersed in such a context.

Regarding the newly introduced TAMIG questionnaire, significant differences were found in the increase of interest for Tango Music in all conditions. This was somewhat expected, considering that most of the population never saw a Tango Concert video, and this has for sure increased curiosity about it. However, the HTC-Vive has had the greatest statistical effect with respect to the classical computer display and smartphone-based virtual experiences. Moreover, even if not statistically significant, the measured immersiveness was higher. These results are in line with other works in literature, confirming that, despite possible problems with VR devices related to their weight, range, and possible dizziness, virtual experiences are a feasible means to make people interested in musical genres toward which they are not used to. Considering that our approach could be generalized also to other activities, in our future works, we would consider also other music genres but also other domains of the theatre world (e.g., ballet). Furthermore, the other measure constructs (Theatre attendance and Media Habits), confirmed our hypothesis on the choice of the population and the video duration.

All in all, in contrast to previous qualitative investigations of various immersive scenarios, our study is unique in both the use of validated scales and the structured comparison of four experimental conditions: a live concert, a concert through a traditional non-immersive music video, and a concert in a virtual reality environment (VR), provided by a basic and easily accessible device or a less affordable but very immersive VR viewer. As emphasized in the Introduction, the present project has the ambition to contribute not only empirically but also theoretically to the current literature by framing a coherent and well-defined scaffolding for the relationship between aesthetic experience, social self, and VR environments, which allows for an investigation on aesthetic emotions and their modulation according to individual motivations and expectations. In our view, this goal can only be achieved through the integration of philosophical, psychological, artistic, and technological competences, through the (badly needed, but often just advocated) dialogue between these disciplines.

In this first attempt, this study, so far, emphasizes how important is the selection of suitable psychological tools to measure the effectiveness and immersiveness of the VR aesthetic experience, which obviously depend on the scenario and on the processes to be scrutinized. Further interesting investigation would pertain the eventual activation of *simulation processes* when looking at vs. taking the role of an embodied artist (i.e., digital twin) that “co-creatively” performs in the play (e.g., theater performance, dance, or concert), within the physical, social, and affective experience of the stage (Scorolli, 2019). The shift in perspective (provided by VR) allows the subject-agent with the opportunity to slip into the role and perspective of others (Gianelli, Scorolli, Borghi, 2013), experiencing their interactions with the external environment, thus directly perceiving both its physical and affective affordances (Caravà and Scorolli, 2020).

Pertaining the *therapeutic applications*, several studies have shown the potential of the arts for mental health (e.g., in older adults: Thomson et al., 2018). Recently, scholars are specifically addressing the effectiveness of therapies founded on VR and music in promoting psychological well-being (Alexanian et al., 2022) as well as in supporting traditional palliative care (Brungardt et al., 2021) and distraction interventions during chemotherapy (Chirico et al. 2020).

In relation to the *social* dimension of the *musical VR experience*, instead, there is not much literature yet, but the effect of different levels of social presence has recently been explored in virtual real-time interactions between pianists by exploiting embodied avatars (Van Kerrebroeck, Caruso and Maes, 2021). In our work we do not introduce avatars nor digital twins, but in a complementary manner to the work by Van Kerrebroeck and colleagues, we put emphasis on the exploration of the (dynamic) intersubjective relationship between the spectator and the object, which in case of musical performances necessarily includes the artists-musicians. Our attempt was oriented at a first framing of the relationship between aesthetic (musical) experience, empathy, and VR environments by accounting for it also in relation with the *affective motivation* (Stamatopoulou, 2018; Stamatopoulou, 2004): “In art, given the non-reciprocity of the beholder and the beheld and the within, the self’s roles and rules become emergent throughout the unfolding action, forming anticipatory action patterns of the morphology of the event and setting the poles that take on signification” (Stamatopoulou, 2018, p. 184).

Consistent with the affective-motivational frame hypothesis, future work developments should focus the analysis of aesthetic experience on the engagement within the *unfolding of the action*. Secondly, empirical work should further address the complex interrelationships

between art and *extended mind*, both from an aesthetic (Matteucci, 2021; Iannilli, 2022) and a cognitive perspective (Borghi et al, 2013). Finally, research should explore the implication of aesthetic appreciation for the effective motivation (Furby, 1991, White 1959) and *psychological ownership*, pointing to the interplay between individuals and those special objects (often intangible in nature) that convey aesthetic emotions, thus in a privileged position to become part of the extended self (Pierce, Kostova and Dirks, 2003). Moreover, considering the general applicability of our framework, we planned to test it with other aesthetic experience in which also the body is involved (e.g., ballet, touristic tours). Of particular interest in such kind of contexts would be the integration of designing process in the virtual experiences, converting the passive participation into an active one. We planned to improve our virtual experiences to create an all-in-one platform to investigate the perceptual and motor processes improvement during motor learning, i.e., perceptual changes associated with improvement in motor skills (e.g., ballet teaching).

From a grounded perspective of cognition, this interdisciplinary work will bring new light to the circular relationship between *aesthetic experience and creative practice*, pushing toward new forms of participatory art. Artificial, immersive, and interactive environments can be exploited to simulate the experience of enjoying/designing the creative product (see the founded Project FAIR, Future Artificial Intelligence Research, PI Milano, M., 2022). In line with the intriguing evidence supporting the coupling of perceptual and motor processes during motor learning (Bayani et al, 2021), these environments would allow the investigation of perceptual changes associated with improvements in motor skills (real or simulated). These technological and societal challenges are consistent, and timely, with respect to the Italian National Recovery and Resilience Plan (PNRR) presented to the European Commission in 2021.

CHAPTER VII

STUDY 3

Aesthetic Experience and Environmental Art

7.1. Introduction¹⁰

Environmental sustainability is one of the most important topics in the current world's political agendas. Human activity is widely recognized to be a major contributor to various natural issues such as pollution or biodiversity loss (Swim et al., 2011; Wynes & Nicholas, 2017), and the primary cause of climate change (Treberth, 2018; IPCC, 2022). Individuals' behaviors and intentions thus represent a crucial part of the global response for the preservation of the environment. This led researchers to look for efficacious ways to promote various kinds of pro-environmental behaviors (PEB) (Grilli & Curtis, 2021). PEB is considered as a set of altruistic actions related to environmental conservation, such as recycling, that consequently contributes to natural environmental sustainability (Lange and Dewitte, 2019; Li et al., 2019; Steg et al., 2014; Stern, 2000).

The study of the role of art is one area of investigation concerned with the urgency to communicate and to act on environmental challenges that humanity is facing. How art can shape behaviors has been debated since ancient times (Belfiore & Bennett, 2007). The influence of art seems to be defined by some specific characteristics when linked with the disclosing of environmental issues. One of these characteristics is that art is considered a singular and unique form of communication, especially when compared to scientific discussions (Klockner, 2015). Indeed, several environmental problems are usually hardly noticeable in everyday life, and art can help to visualize it in a powerful way, synthesizing complex scientific information and conveying new ways of looking at issues, thus striking deeper than scientific data alone (Curtis et al., 2012).

¹⁰ Naddei Grasso, E., Dehove, M., Mastandrea, S., Scorolli, C., Leder, H. (2024). "When the meaning of the content is not enough: an investigation on the role of plastic waste visual art in influencing environmental intentions and donations".

At present, this study is submitted to the journal *Empirical Studies of the Arts*. The following report represents a larger and more detailed version of the study, necessary for the purpose of the present thesis.

Specifically, regarding environmental challenges, a specific subtype of art, called environmental art, is widely encountered. This type of art is meant to encourage discussion and action in relation to environmental issues (Pitt, 2019; Marks, Chandler, & Baldwin, 2016). Expressly, “Environmental Art” is an umbrella term that encompasses all works of art that concern and address environmental topics, whether brought in galleries or displayed outdoors (Thornes, 2008), and regardless of the medium (i.e., paintings, photographs, sculptures, canvases, videos, or land samples), style, and position advocated by the artist (Bulot, 2014). Hence, environmental art consists of "a wide range of work that helps improve our relationship with the natural world" (Bower, 2016, p.2). How does this “improvement” take place? Does it really work? How can we say if improvement is really happening? And if it is, which are the mechanisms that guide this effect? The idea for the present study originates from these questions.

In line with Bulot (2014), two essential mechanisms in relation to the functions of environmental art were identified. First, as opposed to mere facts and numbers, this art focuses on eliciting the appreciator’s reflective thinking, encouraging high levels of attention to key aspects of an issue, which may develop in greater cognitive interest and understanding of the message. Second, another essential function is related to the elicitation and modification of emotional responses: particularly, emotions elicited by environmental artworks are likely to connect with effects that are normative, in the sense that they may prompt sustainable actions and activism. This can happen by strengthening people’s connection with the natural environment and impacting their values (i.e., desirable goals that serve as guiding principles in life, such as for instance environmental quality (Steg & Groot, 2012)) and beliefs (i.e., referential frameworks which are used when interacting with the environment (Gray, 1985)). The combinations of values and beliefs regarding environmental issues and actions define the individual attitude toward the environment (Schultz et al., 2005). Environmental attitude, in turn, is one of the key elements that can shape pro-environmental intentions (PEI), which are recognized as the best predictors of PEB (Ajzen, 1991). In sum, through cognitive (e.g., reflecting on the message) and affective (e.g., emotional involvement) processes, environmental art may bring to a personal connection with the topic, giving the audience an individual experience of the issue that should provoke change and transformation (Roosen et al., 2018).

Researchers investigated the effect of different forms of environmental art on their audience (Withmarsh et al., 2013), showing how it can raise awareness (Marks, Chandler, & Baldwin, 2016, Curtis, 2011), mobilize small community toward sustainability (Withmarsh et

al., 2012; Bamberg et al., 2015), make reflect and evoke empathy (for a general review see: Curtis, 2020). Some of these findings have shown how both emotional (positive and negative) and cognitive factors are associated with changes in PEB, and how they can be significant predictors when connected between each other: Sommer & Klockner (2019), for instance, found such effects for guilt and shame in relation to reflection of one's personal place and responsibility within the environmental system. Nevertheless, there is still a substantial gap between this literature and the impact of art practices on the wider audience (Burke et al., 2018). Moreover, despite the increasing number of artists who respond to global environmental issues through their work (Nurmis, 2016), there is still little empirical evidence that directly assesses the impact of art on PEI and PEB (Curtis et al., 2014; Blasch & Turner, 2016), and lots of questions still to be answered.

In the present study we focused on artistic visual stimuli addressing an environmental topic that is quite familiar to the general population, i.e., plastic waste. Indeed, most plastic packaging is not collected for recycling after use, and their production is expected to double over the next two decades (MacArthur, 2017; d'Ambrières, 2019). Vast quantities escape into the environment, dumped in landfills (Evode et al., 2021) or ending up in the oceans (Verma et al., 2016), thus making plastic a crucial issue for the environment (Oberoi et al., 2021; Oberoi & Garg, 2021). Hence, we decided to use images of environmental artworks concerning the plastic waste issue.

Generally, the use of pictures and visual images represents one of the main mediums through which environmental issues are widespread and experienced (O'Neil & Smith, 2014), and the media (i.e., the way the information is presented to the viewer) can be crucial for positive impact on environmental issue salience, knowledge, and pro-environmental behavior (Huang, 2016; Nicholson-Cole, 2005). Indeed, visual imagery of climate change can be a powerful tool to prompt emotional engagement and PEB (Boomsma, 2013; Kollmuss and Agyeman, 2002). This digital visual format allows researchers to test hypotheses in laboratory settings. Though, visual inputs about environmental issues may bring mixed outcomes depending on several factors, including individual differences, product category, and information treatment (Monsteller, 2014). Some research, for instance, recommends that environmental art should move away from negative framing (Sommer & Klockner, 2021; O'Neill et al., 2010) and be more solution focused. Yet, different studies on the effects of videos, for instance, reported contrasting results on whether it is more effective a positive or negative framing (for more details see Diessner et al., 2023). Few studies have empirically examined whether positive or negative images are more effective at engaging attention and

promoting behavioral change. Salazar et al. (2022) tested the impacts between images of marine plastic pollution on ocean ecosystems (negative valence) vs. images of pristine ocean ecosystems (positive valence). From those who experienced the negative exhibit, they found more engagement and pledges to act in favor of the environment in the future. On the other hand, no significant difference in donations was found (i.e., an immediate measure for PEB).

Similar to Salazar et al. (2022), our study measures pro-environmental intentions (PEI) and donations (PEB) comparing plastic pollution images with pictures of clean natural environments. Though, instead of real plastic pollution snapshots (as in Salazar's study), here we used pictures of environmental artworks, namely, artistic installations made with recycled plastic waste in a natural environment. This allowed us to investigate precisely the role of this type of art (i.e., plastic waste installations made in nature), comparing it with pictures representing only the respective natural context without the artistic component/intervention. Hence, this study is meant to explore the effects of art by comparing visual artistic images with images of nature, both being accounted as possibly influential for intentions and behavior.

Visual arts are considered as a special form of communication for environmental issues (Roosen et al., 2017; Klockner, 2015), as they can affect our values, beliefs, and attitude (Reid et al., 2005). Previous studies show that both positive and negative affect can bring to deep cognitive reflecting (Klockner & Sommer, 2021; Blasch & Turner, 2016), increase salience (O'Neill et al., 2013), and influence intentions to act in sustainable ways (Coelho et al., 2017; Tapia et al., 2013). Regarding the impact of nature, we know that exposure to nature can increase positive affect (McMahan & Estes, 2015; Joye & Bolderdijk, 2015). Previous studies report that images of natural landscapes can be a trigger for positive emotions, as is shown in studies of health (Velarde, 2007), as well as in green advertising (Hartmann & Apaolaza-Ibanez, 2009). Exposure to videos of nature can produce sustainable behavior (Zelenski et al., 2015) and donations in favor of environmental associations (Arendt & Matthes, 2016). Therefore, both kinds of visual stimuli (environmental artworks and pictures of nature) should trigger emotional and cognitive mechanisms that, in turn, may prompt behavioral reactions, but which kind of imagery is more effective still needs investigations.

Therefore, the present study aimed at investigating: a) the role that a specific kind of environmental artworks (namely, plastic-waste installations) can play in affecting pro-environmental intentions (PEI) and behavior (PEB) in favor of the environment, and b) if any kind of influence exist, which are the prevalent mechanisms that guide it. To these aims, we measured PEI pre-and-post exposure to the visual stimuli, and the willingness to make a monetary donation (PEB) at the end of the experiment, as well as the affective and cognitive

responses related to the aesthetics experience, and the individual trait characteristics in relation to the protection of the environment. In the next lines, we will further comment on our specific choice of measures for the present study. Specific research questions narrowing down our aims will be introduced at the end.

7.1.1 Introduction to the measures and the research questions of the present study

Pro-environmental intentions (PEI) are usually considered the most relevant predictors of behavior. Following the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975) and the Theory of Planned Behavior (TPB) (Ajzen, 1991), intentions are related to a high probability for a given behavior to be performed (Sheppard et al., 1988; Taylor and Todd, 1995; Venkatesh et al., 2023). Evidently, they may not be enough to result in actual behavior, but they can still represent the motivating factors that influence behavior, and it is widely shown in literature how they can be valid predictors with different kinds of behavior (Ajzen, 2005; Armitage and Conner, 2001; Hagger et al., 2002; Morwitz & Munz, 2021). Thus, here we opted to measure intentions through self-reports pre-and-post exposure to the stimuli, and we focused on four specific types (namely: to change behavior, for pro-environmental behavior, for activism, and for recycling) that are relevant to the type of environmental artworks chosen, i.e., installations with plastic waste.

Pro-environmental behavior (PEB) includes various types of actions, such as recycling and reuse of goods (Aizawa et al., 2008; Byrne and O'Regan, 2014; Hansmann et al., 2006; Klockner and Oppedal, 2011), energy-saving behaviors (Berardi, 2017), transportation selection (Eriksson et al., 2008; Kahn, 2007), purchasing energy-saving electronic goods (Young et al., 2010), or reducing waste (Poldnurk, 2015). Though, studies on people's donation behavior are scarce (Piao & Managi, 2022) or focused almost exclusively on financial characteristics of non-profit organizations (Paxton et al., 2020; Ressler et al., 2021). Fukui and Toyoshima (2014) found that music enhanced pro-social donations, whereas Franzen & Mader (2020) did not find any evidence using videos. Here, we decided to assess PEB investigating donations in relation to image exposure, adapting the social behavior measure used in Stamkou et al. (2023).

In terms of affective aspects, we measured the evaluation of beauty and the emotional reaction to the experience. Both beauty (Trupp et al., 2022; Martínez-Martí et al., 2018) and pleasure (Berridge & Kringelbach, 2011; Mastandrea, Fagioli, & Biasi, 2019) can affect and improve well-being and emotional reactions, which in turn can influence our goals and needs,

modulating the resulting behavior (Brehm, Miron and Miller, 2009; Nelissen et al., 2007). Thus, here we investigated for any correlation between beauty, emotions (positive and negative), and PEI and PEB.

To check for a more cognitive pathway, we included questions about meaningfulness and cognitive reflection. Meaning-making is one of the key components that emerges throughout most of the art-viewing perception models (Leder & Nadal, 2014; Pelowski et al., 2016), and it can be associated with the “cognitive mastering” stage of an aesthetic experience, where one creates and/or discovers meaning by making self-related interpretations, associations, and connections to existing knowledge, experience, and memories (Pelowski et al., 2017). Thus, art can be a catalyst for such processes to emerge, allowing for intellectual understanding and self-engagement, which in turn can bring to re-framing of attitudes and beliefs (Knizek et al., 2021), two crucial elements in predicting or even influencing behavior (Ajzen, 1991). Therefore, here we explored the correlation of these components with PEI and PEB.

Finally, the change of intentions and behavior is also related to several individual traits and factors that may guide one’s choice in favor of the environment (e.g., subjective norms, attitude, behavioral control). Here, we measured several variables considered as the most influential according to the theory of planned behavior (TPB) (Ajzen, 1991), and the value-belief-norm-theory (VBN) (Stern, 2000), both widely accepted approaches in relation to the study of sustainable and environmentally favorable human behavior (Oreg & Katz-Gerro, 2006; Canlas et al., 2022; Canlas & Karpudewan, 2023).

In sum, we consider this an exploratory research in which we assessed affective (beauty, positive and negative emotions) and cognitive (meaningfulness and reflecting) factors in response to artistic imagery related to a specific environmental issue (namely, plastic pollution), thus investigating on the role of art-images in influencing PEI and PEB (donations) by comparing it with nature-images, and checking the possible correlations of this effect with the various individual traits. Specifically, we implemented these four exploratory research questions:

RQ1: Did the PEI (i.e., changing behavior, recycling, activism, and pro-environmental behavior) before and after the experiment differ across conditions?

RQ2: Does people's PEB (i.e., donation) differ across conditions?

RQ3: Can the results for the PEI (RQ1) and PEB (RQ2) be explained by the affecting (beauty and emotions) and cognitive (meaningfulness and reflecting) responses?

RQ4: Can the results for the PEI (RQ1) and PEB (RQ2) be explained by individual differences among participants?

7.2. Methods & Materials

7.2.1. Participants

As the present study used the same measure of PEB (donation of a lottery ticket) as well as the same analytical strategy of Stamkou et al. (2023), the study was used to derive the sample size. The power calculation performed in Stamkou et al. (2023) indicated that, to detect a small effect size (odds ratio = 1.5) in a two-tailed negative binomial regression ($\alpha = .05$, $\beta = .80$), the total sample size should be 158 participants. Starting from this target number for our sample size, we checked what would be the effect size for the other planned analyses for the PEI variables (i.e., mixed ANOVAs). A sensitivity analysis was performed with G*Power (Faul et al., 2007) for between-within interaction ANOVA with an α of .05, a β of .80, and a sample size of 158. The predicted effect size was 0.13, which is considered small (according to Cohen, 1988). Upon completion of the experiment, the data of 163 participants were collected (76% female, 23% male, and 1% other). Five supplementary participants were recruited in the eventuality of data loss during data analysis. The participants were between 18 and 70 years old ($M_{\text{age}} = 22.86$; $SD_{\text{age}} = 5.87$).

Participants had the opportunity to perform the study either in English or in German. Most of the participants' mother-tongue was German, the English version was chosen by non-natives who were more comfortable in English (with high level of proficiency, being university students). A total of 145 participants performed the experiment in German. The remaining 17 participants did the experiment in English. Note that one participant did some parts of the experiment in English and other parts in German. German-language participants specified also their degree of education. The sample was mainly composed of non-experts in art as 93.87% of the participants did not study art or art history (educational background information about the sample is available in the §1 of Appendix B). From the descriptive results of the Vienna Art Interest and Art Knowledge (VAIAK) questionnaire (see §9.1 of Appendix B for more information), our sample was considered not to have a strong interest in art ($M = 4.00$; $SD = 1.18$; range: 1.18-6.55).

Most participants were university students recruited through the internal recruitment system of the University of Vienna. They received credits for participating in the study. Only 21 participants were recruited through a different recruitment system and were paid (10€) for participating. Since the information about the study included the possibility of winning a 100€ lottery prize for everyone, we do not believe that monetary compensation (rather than the credits) may have been an incentive that significantly differentiates the performance between the two groups (university credits vs. 10€).

7.2.2. Experimental design

To investigate the impact of environmental art on PEI and PEB, a mixed design was applied with two factors: Condition and Time. The present experiment had three Conditions. The first condition was composed of only artworks. This condition was considered as a baseline for the two other conditions as it tests the reaction of participants not to a blank screen but to a similar type of stimuli to the one the present study is interested in testing, i.e., environmental art. This condition is hereafter referred to as Art Baseline condition (ABLC). The second condition was composed of the same artworks as for the ABLC, plus environmental artworks (i.e., the main stimuli of interest). This condition is hereafter referred to as Environmental Art condition (EAC). The third condition was composed of the same artworks as for the ABLC, plus pictures of the natural environment. This condition controlled for the presence of artistic farming of plastic waste and is hereafter referred to as Nature condition (Nc). Figure 1 displays a visual summary of the three *Conditions* and their composition, with some examples of stimuli shown to the participants. Note that the following section (§7.2.3 Stimuli) will further develop on the technical aspects of the three conditions. Participants came only once to the laboratory and were exposed to only one *Condition* (either ABLC, EAC, or Nc). Condition was thus a between-subject factor.

The *Time* factor was only used for the investigation touching upon PEI. As we were interested in seeing if participants' intentions would be influenced by the experience with the environmental artworks, measures were evaluated before and after the exposition to their allocated *Condition*. *Time* (pre, post) was a within-subject factor (see §7.4 Procedure part and Figure 3 for more information).

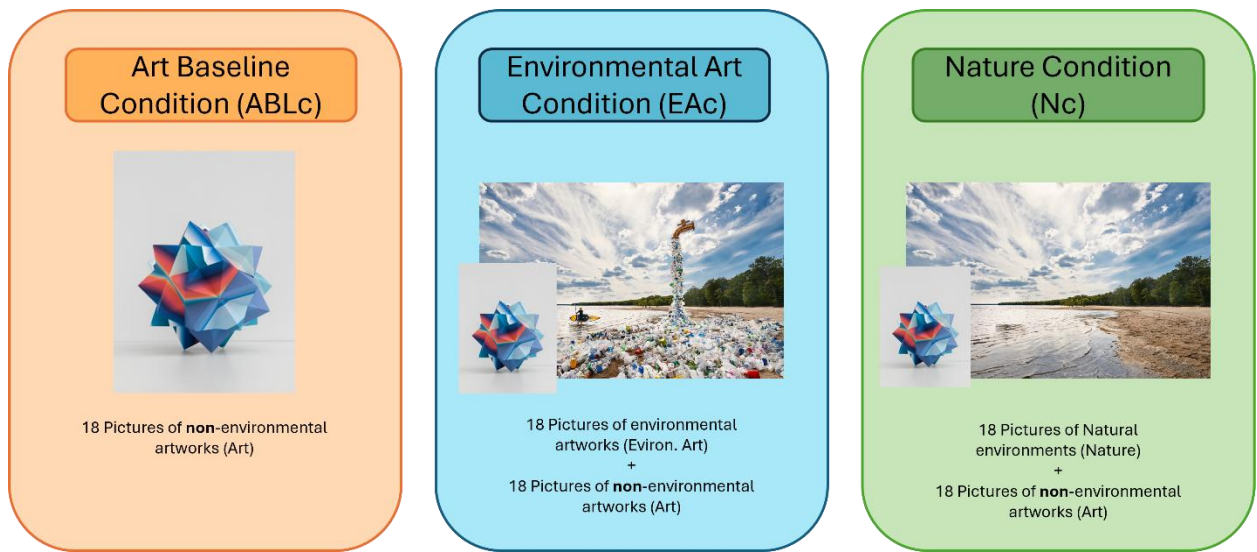


Figure 1. Visual representation of the three Conditions with example of stimuli

7.2.3. Stimuli

The Art Baseline condition (ABLc) was composed of 18 pictures of non-environmental artworks. There were different kinds of abstract contemporary artworks (installations, sculptures, and paintings) selected from various artists who are not expressively engaging with environmental art (i.e. without the explicit purpose to raise awareness toward environmental issues), and in which there is not any explicit reference to nature at all. In addition to its role of baseline, the use of these 18 pictures of non-environmental artworks in the other two conditions (EAc and Nc) was meant as distractors, i.e., so as to not make the main goal of the study obvious (i.e. stimulating intentions and donations through environmental artworks and/or nature), which otherwise could have been too obvious. Moreover, being not our focus of interest, we opted for abstract artworks which are usually less cognitively understandable and have lower emotional engagement for non-expert compared to representational art (Szubielska et al., 2021).

Environmental Art condition (EAc) consisted of 36 photographs, including 18 pictures of environmental artworks and 18 pictures of non-environmental artworks. All the environmental artworks (except two) consisted of plastic waste installation made in a natural environment (e.g. beach, sea, or forest). The environmental artworks concerned works by two artists, Alejandro Duran and Benjamin Von Wong. Twelve artworks were selected from the “washed up” series of Alejandro Duran. He created this collection of artworks by collecting a

huge quantity of plastic waste found in the natural reserve of Sian Ka'an, along the Mexico's coast. He then organized it by color (the plastic is not painted) and made different kind of artistic creations with it, resulting in a photo series that "depicts a new form of colonization by consumerism, where even undeveloped land is not safe from the far-reaching impact of our disposable lifestyle".¹¹ The other six environmental artworks were selected from different projects of Benjamin Von Wong (see §2 of Appendix B for more details). This artist has done several different projects all around the world, and his works and photos are meant to amplify positive impact and spread awareness about the world's plastic problems.¹² Although they are made in a much different style, his artworks that we selected consist as well in big installations made using plastic waste. In four of these artworks the plastic-waste composition is framed within a natural environment (e.g. the beach, see Figure 2A). The remaining two artworks were instead created in studio, representing respectively a man swimming underwater in a sea made of plastic cups, and a dead mermaid brought to the sandy coast by a sea of plastic bottles.

The Nature condition (Nc) consisted of 36 photographs, including 18 pictures of natural environment plus the same 18 pictures of non-environmental artworks present in the ABLc. Specifically, the nature-pictures have been created modifying the environmental art pictures used for the EAc (all except the two that are not made in a real natural environment, see §2.1 of Appendix B for more details). The editing for the Nc consisted in eliminating the artistic installation, resulting in pictures having the same natural scenario of the environmental-artworks images but without the artistical component (i.e., the plastic installations, see Figure 2B). This manipulation was done using the generative fill feature recently implemented by Adobe Photoshop 2024 (version 25.4.0.319). The feature is a new AI tool that can substitute some parts of a picture with fills that perfectly match with the picture's setting/location, so as to look like a realistic representation of what could have been the (unseen) background of the picture behind the installation. In this way, it was possible to have a perfect control for the artistic framing of the EAc, where the only difference with the Nc was the presence of the artistic installation, thus allowing for a controlled comparison between environmental artworks and picture of nature. The complete list of the artworks and more details are provided in the §2.2 of Appendix B (see Figure (i) for further examples of editing).

¹¹ <https://alejandroduran.com/washedupstatement>

¹² <https://www.vonwong.com/>



Figure 2. Figure 2A is shows an artwork by Benjamin Von Wong and used for the EAc, whereas Figure 2B is its modified version without the artistic installation used for the Nc.
 [Credits for Figure 2A: Giant Plastic Tap © Benjamin Von Wong #TurnOffThePlasticTap.]

7.2.4. Variables

The dependent variables (DVs) included: pre-assessment individual fixed values (e.g. recycling attitude), pre-and-post exposure measures related to intentions (e.g. intentions for pro-environmental behavior), variables measured during the exposure for each image shown (i.e. beauty and meaningfulness questions about the artworks/pictures), post-only variables (e.g. emotions after the exposure), and one behavioral variable (i.e. donations). All variables

(except familiarity with the artworks, art interest, and donations) were measured through responses given on a continuous scale (from 1 to 100 or from 0 to 100). Donations were measured by the number of vouchers handed over after the experiment (more details in §7.2.4.2). The complete list of items for all the following variables is provided in §3 of Appendix B.

7.2.4.1. Pro-Environnemental Intentions (PEI) variables.

Environmental actions can include lots of specific domains spanning from energy consumption to recycling. We selected four different kinds of measurements for intentions (i.e. willingness to act): intentions to change behavior, intentions for recycling, intentions for pro-environmental behavior, and intentions for activism. The selection for these intentions variables was made taking into consideration the topic of plastic waste (e.g., items on intentions to change behavior concern consumption and recycling) and the behavioral measure represented by donations (as for some items on intentions for pro-environmental behavior concerning the willingness to pay for environmental protection).

7.2.4.1.1. Intentions to change behavior. We used six items from Gansser & Reich (2023), namely those related to the “Consumption” sub-category (e.g. “In the future, I will try more often to buy less non-durable and more high-quality products with a longer lifetime”, strongly disagree - strongly agree). Since our environmental artworks concern plastic waste, we decided to focus on this single target variable and not include the other three areas measured in the study (i.e., Food, Mobility, and Energy). Participants' answers to the six items were averaged to obtain the main variable of Intentions to change behavior (as suggested by the Gansser & Reich (2023)'s Principal Component Analysis).

7.2.4.1.2. Intentions for recycling. We adopted one more general item from Knussen et al. (2004), asking “How likely will you recycle within the next month?” (not recycling - recycling everything), and one more specific about materials from Davis et al. (2002), stating “How likely will you recycle cans, bottles and paper on a fortnight basis?” (highly likely - highly unlikely). The answers to the item from Davis et al. (2002) had to be reverse coded. As these two measures were taken from two different sources and as no formal grouping of variables analyses were performed, the two variables were kept separate. They are hereafter referred to as “Recycle 1” and “Recycle 2”.

7.2.4.1.3. Intentions for activism. It consisted of five items from Swim and Geiger (2017). Items concerned the likeliness of making different sorts of political actions in favor of the environment (e.g. “How likely would you share with a friend a petition that supports climate

change action”, very unlikely - very likely). The answers to item number two (“How likely would you vote for a political candidate based upon their opposition to climate change policy?”) were reverse coded. Following Swim and Geiger (2017), the five items were averaged to obtain the main variables of Intentions for activism.

7.2.4.1.4. Intentions for pro-environmental behavior. *Consisted of four items from* Diessner et al. (2023) concerning the willingness to do something for the environment (e.g., “How willing would you be to pay higher prices to protect the environment?”, very unwilling - very willing). To be comparable with the other intentions variables, the result of the sums of the items was brought back to a percentage.

7.2.4.2. Pro-Environmental Behavior (PEB) variable.

At the end of the experiment, each participant received a ticket valuable for the lottery, and only at that moment they were instructed that they could either keep it or donate it, so that in case of winning, the money would go to an environmental association (see more details in §3.2 of Appendix B). They could do that by putting the lottery ticket in a box. The box was placed in a strategic spot outside the experiment room, easy to see for the participants on their way out of the laboratory, but at the same time sufficiently isolated to allow for privacy (i.e., participants could not be seen). PEB was thus measured by a dichotomous scale (Donation: Yes/No).

7.2.4.3. Affective and cognitive measures of aesthetic experience.

Participants were asked to rate different features in relation to each individual stimulus and to the whole experience. As mentioned in the introduction, one goal concerned the study of the affective and cognitive mechanisms related to the experience of the stimuli we selected. To investigate what could be the driver of the effect that might be found for the PEI and PEB, variables about participant’s affective (Beauty and Emotions) and cognitive (Meaningfulness and Cognitive reflection) processes were measured.

7.2.4.3.1. Beauty. Beauty was assessed twice during the experiment. The first assessment was done after each picture was shown, by asking “How beautiful did you think the image was?”. The second assessment was done after the exposure to the stimuli. It was asked to the participant “To what extent do you think the images were beautiful?” (dimension assessed with a single item, in line with the questioning style in empirical aesthetics, see Pelowski et al., 2017 for review). Single images were rated on a continuous scale ranging from 1 (“not at all”) to 100 (“extremely”), while the whole experience item ranged from 0 to 100.

7.2.4.3.2. Emotions. Emotional reactions were assessed only after the whole exposure session with the question “To what extent did this experience bring up each of these feelings with you?” (adapted from Sommer & Klockner, 2019). Fourteen different emotions were assessed, including seven positive (happiness, hope, awe, surprise, inspiration, relaxation, enthusiasm) and seven negatives (guilt, sadness, disappointment, helplessness, anger, anxiety, shame). Responses ranged on a scale from 0 (“not at all”) to 100 (“extremely”). Two composite items were created to represent a broad measure of positive emotions and negative emotions. Both were obtained by averaging the scores to the seven positive or seven negative emotions.

7.2.4.3.3. Meaningfulness. As for beauty, meaningfulness was also assessed twice during the experiment. The first assessment was performed after each picture was shown. Three different questions captured the concept of meaningfulness. Specifically, they were shown in this order: the first question denoted the understanding of the images’ content, while the other two regarded respectively their relevance for the self and for society. We included these last two items because the evaluation of meaning involves an acknowledgement or assessment of the relative personal importance of art, i.e. self-relevance (Vessel et al., 2023; Silva, 2009), as well as its value for society (Dewey, 1958/1929). The second assessment was done after the entire exposure session. Meaningfulness of the whole experience was measured with one single item (“To what extent was the experience of this experiment meaningful for you?”) adapted from Trupp et al. (2023). Single images were rated on a continuous scale ranging from 1 (“not at all”) to 100 (“extremely”), while the whole experience item ranged from 0 to 100.

7.2.4.3.4. Cognitive reflection. Concerning the whole experience judgments, we also assessed cognitive reflecting through four items adapted from the “reflecting on the artwork” questions used in Klockner & Sommer (2021). This measure captured the degree of agreement to which participants felt personally involved (e.g., “This experience makes me think about my own role in the community”). Responses ranged from 0 (“strongly disagree”) to 100 (“strongly agree”). An average of the four items was performed to have a general measure of the variable.

7.2.4.4. Individual trait variables.

The eleven individual trait variables presented below, except for the VAIK, were rated on a sliding scale from 0 to 100.

7.2.4.4.1. New Ecological Paradigm (NEP). Beliefs and concerns for the environment are generally associated with the endorsement of an ecological worldview, which is notably measured by the New Ecological Paradigm (NEP) scale, developed by Dunlap et al. (2000), and considered as one of the best predictors for attitude (Gansser & Reich, 2023). Thus, we

included the 15-items version of the scale (e.g., “Humans greatly abuse the environment”, strongly agree - strongly disagree; German version adopted from Schleyer-Lindenmann et al., 2018) within our pre-assessment variables, the strength of which should be related to change of Intentions (our four main variables). Answers to items 1, 3, 5, 7, 9, 11, 13 and 15 were reverse scored. A mean of the 15 items was computed to give a general score for the NEP (hereafter referred as “NEP”).

7.2.4.4.2. Attitude toward sustainable behavior, Subjective Norm (SN), and Perceived Behavioral Control (PBC). According to the TPB, behavioral intentions (our main variables of interest labelled as PEI) are explained mainly by three factors: attitude, Subjective norm (SN), and perceived behavioral control (PBC). To assess these three individual traits, we adopted the same items used in the study of Gassner and Reich (2023), as well as in Weber and colleagues (2020). Attitude toward sustainable behavior was measured with five items (e.g., “To behave sustainably for me is: very undesirable – very desirable”). A mean of the five items was computed to give a general score for the Attitude toward sustainable behavior (hereafter referred as “Attitude.Sustainable.Behavior”). SN had three items which concerned the opinions of people in the social environment of the respondent with regard to his sustainable behavior (e.g., “Most of the people who are important to me think that I should behave sustainably”, strongly disagree – strongly agree). A mean of the five items was computed to give a general score for the SN (hereafter referred as “Subjective.Norm”). PBC was evaluated with two scales. The first one consisted of five items regarding the difficulty in adopting that specific behavior (e.g., “For me, behaving sustainably is in general: completely impossible - very possible”). The second one consisted of one item: “For me, recycling facilities are: easily available – not easily”. available about the availability to reach recycling facilities (Knussen et al., 2004). The first five items derived from Gassner & Reich (2023). The items were averaged and hereafter referred as “Perceived.Behav.Control1”. The single item derived from Knussen et al., 2004. The item was reverse coded and hereafter referred as “Perceived.Behav.Control2”.

7.2.4.4.3. Attitude toward recycling and Past recycling. Since the environmental artworks concerned plastic waste, we included questions about attitude toward recycling and past recycling. Attitude toward recycling was measured with five items specifically concerning plastic (e.g., “I think that recycling plastic is: useless - useful”) derived from de Groot & Steg (2008). The items were averaged and hereafter referred to as (“Attitude.Recycle”). Past recycling was also measured with two items from Davis & Pallister (2002) and Knussen et al. (2004). The answers to the item from Davis & Pallister (2002) were reverse coded and no

transformations were applied to the Knussen et al. (2004) items. They are respectively hereafter referred as “Past.Recycling1” and “Past.Recycling2”.

7.2.4.4.4. Ascription for Responsibility (AR) and Awareness of Consequences (AC). According to the VBN (Stern, 2000), together with SN, both awareness of consequences (AC) and ascription for responsibility (AR) are two crucial factors in predicting behavior. Items specifically in relation to the topic of recycling were selected to evaluate AR and AC from Davis & Pallister (2002). AC consisted in six items concerning positive conditions related to recycling (e.g., “I think that recycling household waste will conserve energy”: strongly disagree – strongly agree), while AR had four items about the actions that can lead to those conditions (e.g., “recycling my household waste is always worth the effort”: strongly disagree - strongly agree). Both the six items for AC and four items for AR were averaged to obtain two scores and they are hereafter referred as “Aware.Consequences” and “Ascription.Responsability”.

7.2.4.5. Other variables.

In addition to the main variables of interest, the affective and cognitive variables, and the trait variables, additional questions were asked to the participants. These regarded their art interest (VAIAK part I), familiarity with the artworks, to what extent they thought the images to be works of art, the artistic quality, and some distractors variables.

7.2.4.4.5. Art Interest (VAIAK). Part A of the VAIAK (Specker et al., 2020) was included to assess art interest (e.g. “I’m interested in art”, responses ranged from 1 “not at all” to 7 “very much”). The eleven items of part A of the VAIAK can be split into two subparts: the first seven items evaluate participant’s subjective interest, and the last four items evaluate participant’s art-interested behavior. For the present study we used a general score for Art Interest, hence the eleven items were averaged into one single measure of Art Interest. This score is hereafter referred to as “VAIAK.Interest”.

7.2.4.5.1. Familiarity. Familiarity with the artworks was assessed through the question “Did you know any of the artworks?”. If the dichotomous (Yes/No) answer was positive, we asked: “Can you name the artwork/s or the author/s that you knew?”.

7.2.4.5.2. Work of Art and Artistic quality. The extent to which the participants thought the images to be works of art was assessed with one item (ranging from 0 “not at all” to 100 “extremely”). Artistic quality was also assessed with one item: “The images appear to be of considerable artistic quality” (response range from 0 “strongly agree” to 100 “strongly disagree”). Both items were adopted from Klockner and Sommer (2021).

7.2.4.5.3. Distractors variables. As for some of the stimuli (see §7.2.3), in order to prevent participants from guessing the main goal of the study (i.e. stimulating intentions and donations through environmental artworks and/or nature) we also included some questions that could serve as distractors. Thus, participants were asked about intentions related to art through three items. Two of these items regarded the likelihood of seeing more artworks and visiting a museum (e.g., “How likely would you see more artworks now?”, from 0 “very unlikely” to 100 “very likely”). These two items were averaged into one (hereafter referred as “OtherVar_ArtIntention1_Tot”). The third item concerned the likelihood of buying an artwork and was left as a standalone item. Other two distractors-items were: “This experience seems relevant for human rights”, and “This experience seems relevant for the history of art” (response range from 0 “strongly disagree” to 100 “strongly agree”). These two items were not analyzed at all.

7.4. Procedure

The procedure was divided in two main parts: (1) Pre-experiment and (2) an onsite experiment (see Figure 3, presenting a visual summary of the procedure and all the measures used during the experiment). At the time of registration, participants were informed that the study was about the evaluation of beauty and meaning in relation to different kinds of artworks and images. It was also made clear to the participants that the onsite experiment would be composed of two parts and that the participation would give them the chance to participate in a lottery for 100€.

After registration, the online pre-assessment questionnaire was sent, which included: demographics, all the trait measures described in §7.2.4.4, and the intentions variables (§7.2.4.1.). Participants needed to complete it at least 3 days (72 hours) before coming to the lab in order to participate in the experiment. The order of all the items was randomized.

The onsite experiment took place at a laboratory facility of the Department of Emotion, Cognition, and Methods in Psychology of the University of Vienna, between March and May 2024. In the laboratory, participants were shown with the images of one of the three Conditions (randomly assigned). Pictures were projected on a screen (2560x1440), each one for 15 seconds. An exposure of 15 seconds was considered to be the right presentation time. Indeed, past literature reports that the average time spent on an artwork is around 20 seconds, but it may vary a lot among people, artworks, and context (Brieber et al., 2014), where in most cases it can be around or even less than 10 seconds, with a median of 17 seconds (Smith et al., 2017;

Smith & Smith, 2001). Above all, 10 seconds should be sufficient presentation time for an interpretative activity of artworks (Carbon & Leder, 2005). Here, we wanted participants to have enough time to reflect on the stimuli-artworks and solicit understanding and appreciation (Leder et al., 2006), thus we opted for repetition (18 images concerning the same issue), and a medium-long presentation time (15 secs), but not too long, so to avoid boredom.

After each image, participants responded to four questions assessing the beauty and meaningfulness of what they had just seen. Before the start of the experiment, they were given instruction about these questions (e.g., for beauty: “we ask you to indicate how beautiful you personally find the picture you have just seen, where 1 means that you do not find the picture beautiful at all, and 100 means that you find the picture extremely beautiful”). The questions were shown always in the same order: first the question assessing beauty, and then the three questions assessing meaningfulness (see §7.2.4.3.3). To check for the participant's attention, we included catch trials (see §7.5 for more details about the catch trials). This part lasted around 12 to 18 minutes, depending on the time spent responding (time was shorter for the ABLc since it had less stimuli). To check for the participant's attention, we included catch trials (see §7.5 for more details). This part of the experiment was performed using PsychoPy, version 2023.1.3 (Peirce et al., 2019).

After the exposure session, participants were redirected to an online questionnaire which included the intentions variables and all the other post-exposure measurements. The order of all the items was randomized. To complete this, it could take around 10 or 15 minutes (depending on the time participants took to respond), so that the entire lab session would last 30 minutes at most. All questionnaires were administered through Qualtrics platform (Qualtrics, Provo, UT).

At the end of the experiment and before leaving the lab, participants were given a ticket with their number for the lottery. At the end of the experiment and before leaving the lab, participants were given a ticket with their number for the lottery. Only at that moment they were instructed that they could either keep it or donate it. Donations could be made by putting the ticket in a box outside the experiment room, in the sight of no one. Note that participants did not know about the possibility of donating their lottery ticket until the very end of the experiment, since we wanted their responses to be as most spontaneous as possible.

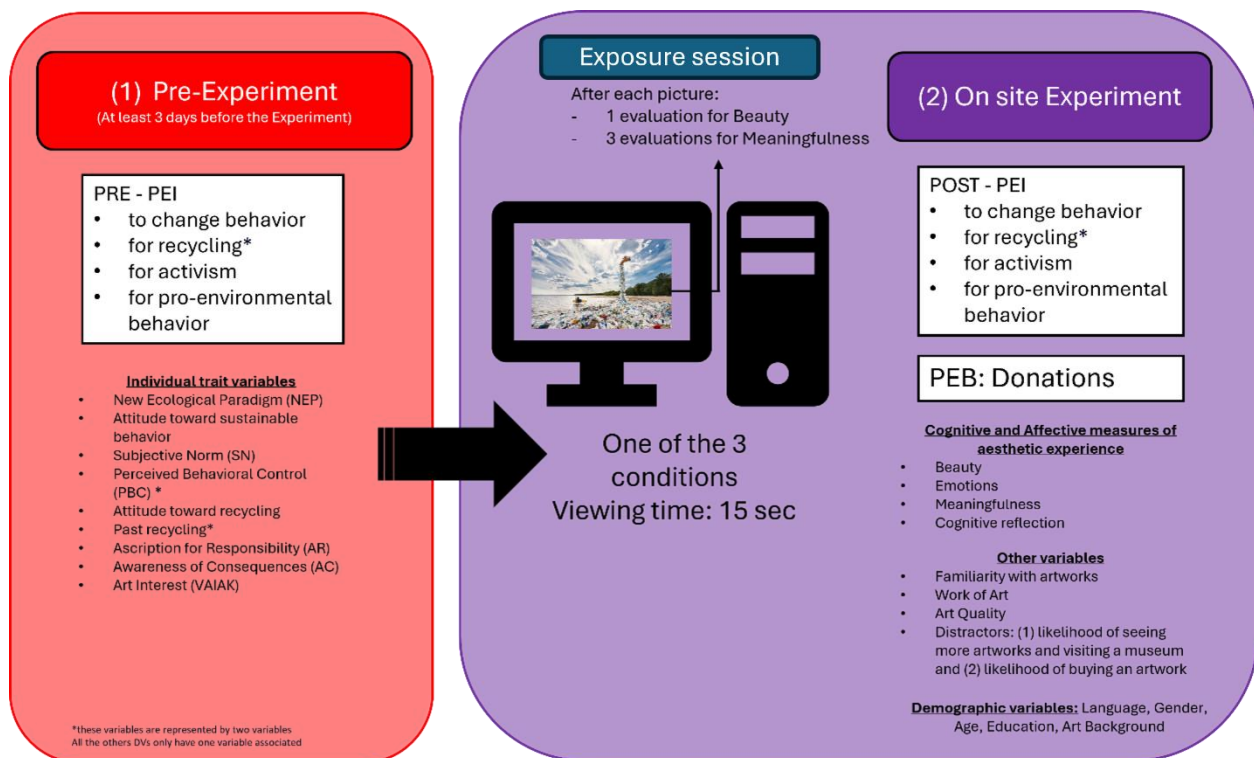


Figure 3. Procedure of the experiment.

7.5. Pre-processing, data cleaning and final data set

All preprocessing steps were made with R (cite R). To assess the quality of the data, some “catch trials” were added throughout the exposure session in the on-site part of the experiment. The catch trials consisted of six questions asking the participant to answer either 1 or 100 (see §4 of Appendix B for the full analysis of the catch trials). After the analysis of the catch trials, nine participants were removed, leaving the final sample for the analysis to 154 (75% female; 23% male; 1% other gender; $M_{age} = 22.68$; $SD_{age} = 5.88$; range: 18-70 years). The final sample remained relatively equal in terms of number of participants in each condition ($n_{EAc} = 52$; $n_{Nc} = 52$; $n_{ABLC} = 50$). The main variables of interest were the intentions (to change behavior, to recycle, for activism, for pro-environmental behavior) and the behavior (donation).

All data are publicly available on OSF: <https://osf.io/z7tgb/>

7.6. Results

All analyses were performed with R studio (cite R). Assumptions checks were performed for each analysis and are available in the R code (see the OSF folder). To run some models, a reference group was required for the *Condition* factor (all variables) and for the *Time*

factor (only for variables measured pre and post). When facing such cases, it was decided to run two models: one with the ABLc as the reference group since this condition represents a theoretical base line (controlling for both EAc and Nc); and another one with the Nc as the reference group, as this condition is a controlling for both the art and nature presence. Doing this also allowed us to see how the condition of interest (EAc) behaves, and to have a full set of comparisons between the three conditions.

7.6.1. Descriptive statistics

7.6.1.1. For the main DVs

Figure 4 displays a raincloud plot of our six main variables of interest. Each column of the graph shows all the datapoints jittered, the mean and 95% CI of the Pre/Post measurement (in black and grey), the boxplots (First quartile, median, third quartile and the whiskers), and the half-density distribution plot. All numerical data linked to Figure 4 are reported in Table S1 (see §5 Appendix B). All in all, participants scored relatively high on all intention variables, the lowest score being 46.30 out of 100 for the post measure for Activism and 76.38 out of 100 for the post measure for Recycling 1.

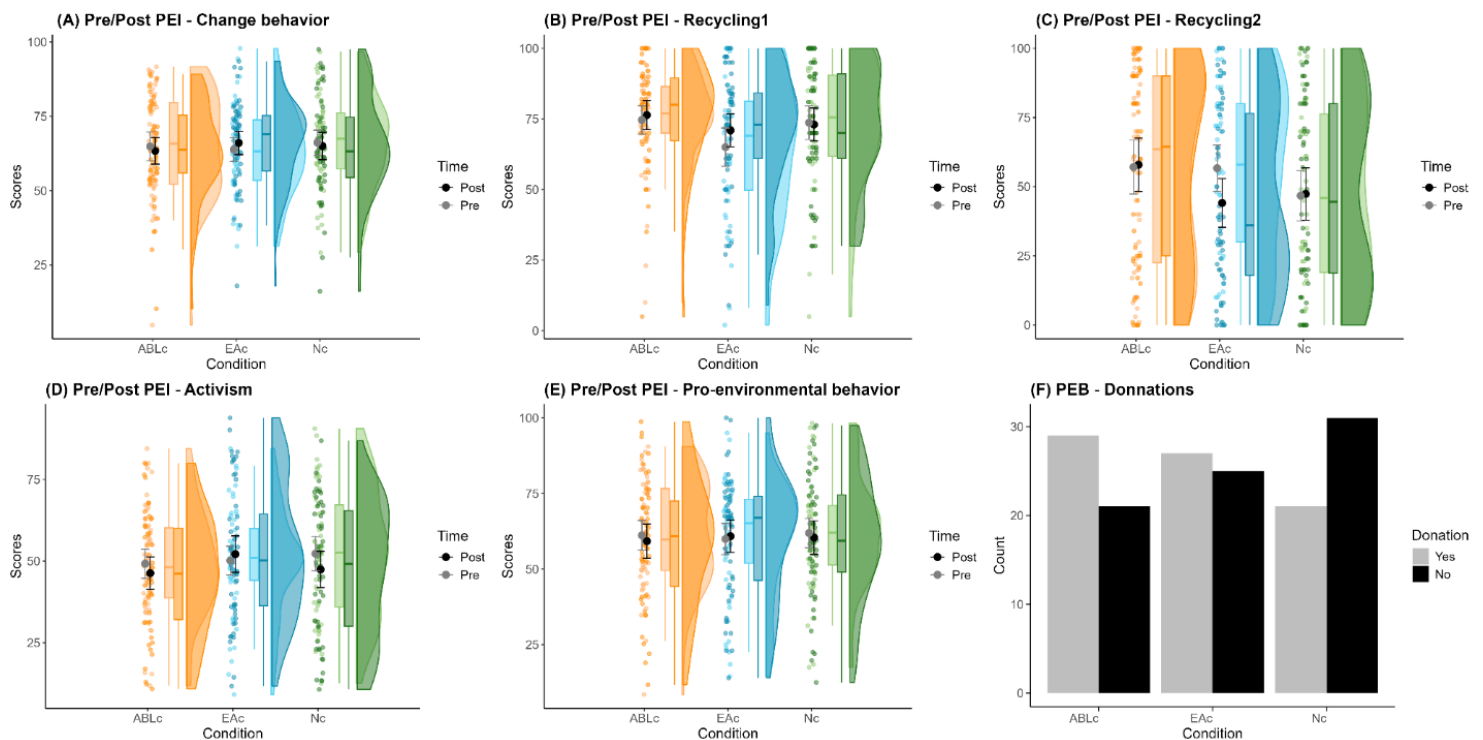


Figure 4. Raincloud plots of our six main variables of interest.

7.6.1.2. Other variables

Participants were not familiar with any of the pictures presented in the three *Conditions*. Indeed, 98.70% of the sample reported that they did not see any of the stimuli before (only 2 participants said to have seen some of the artworks before but were not able to name it).

Participants evaluated the presented stimuli to be of medium artistic quality ($M = 49.29$; $SD = 25.42$, range of answers: 0 to 100), and on average they thought that the stimuli were works of art ($M = 62.97$; $SD = 25.01$, range of answers: 0 to 100), especially for the EAc ($M = 66.94$, $SD = 24.46$, median = 72.5).

After the exposure session, participants were relatively likely to visit more museums and see more art ($M = 53.67$; $SD = 25.18$, range of answers: 0 to 100). On the other hand, participants were not likely to purchase artworks at the end of the experiment ($M = 25.32$; $SD = 26.07$, range of answers: 0 to 100).

The descriptives broken down per condition for artistic quality, work of art, likelihood to visit more museums and see more art and likelihood to purchase artworks at the end of the experiment are reported in §6 of Appendix B (Table S2).

7.6.2. Did the PEI (i.e., changing behavior, recycling, activism, and pro-environmental behavior) before and after the experiment differ across conditions?

The set of variables for PEI were measured twice (pre/post exposure to the stimuli). As reported by O'Connell et al., 2018, there are several ways to approach a Pre/Post data set. In their study, they test five common methods used to analyze Pre/Post data sets. They first concluded that each method leads to unbiased treatment effect estimates. Even though their second conclusion is that the ANCOVA models were the most effective, we decided to first analyze our data with an ANOVA with one five variables representing the intentions as DVs and with *Condition* (ABLC, EAc or Nc; between-subject factor) and *Time* (Pre or Post; within-subject factor) and IVs. The results of the ANCOVA (DVs: Post-measurement from each of the five variables representing the intentions; IV: Condition; Covariate: Pre-measurement from each of the five variables representing the intentions) are reported in §7 of Appendix B. Together with the visual interpretation of Figure 4, we believe that these three different assessments (ANOVA, ANCOVA and graphical representations) allow to strongly conclude on the effect of *Condition* on the Intentions.

After the assessment of the ANOVA assumptions (see R code on the OSF), it was decided to use parametric tests for changing behavior, activism, and pro-environmental behavior. The “*anova_test*” function of the “*rstatix*” R package (Kassambara, 2023) was used

to run the parametric ANOVA. As the two variables representing recycling were not normally distributed, non-parametric alternatives were used for the analysis. For the ANOVA analysis, the “nparLD” function from the “nparLD” R package (Noguchi et al., 2012) was used as non-parametric alternative. It is specialized in longitudinal data in factorial experiments (Noguchi et al., 2012). For the ANCOVA analysis, the “lmrob” function from the “robustbase” R package (Maechler et al., 2024) was used as non-parametric alternative. It computes models that have high resistance to outliers and violations of normality (MM-type estimators for linear models) (Verardi & Croux, 2009).

7.6.2.1. Intention to change behavior

Intention to change behavior was set as DV, *Condition* was set as the between-subject factor variable, *Time* was set as within-subjects factor variable. The participant identifier was also entered in the formula call. The result of the type 3 ANOVA revealed no statistically significant main effect of *Condition* ($F(2, 151) = 0.12, p = .88, \eta^2 = .002$) or *Time* ($F(1, 151) = 0.03, p = .874, \eta^2 < .001$) as well as a non-statistically significant interaction between *Condition* and *Time* ($F(2, 151) = 1.89, p = .16, \eta^2 = .02$). ANCOVA’s results, reported in §7 of Appendix B, agree with the results of the ANOVA: when controlling for the pre scores on intention to change behavior, the post scores did not show any differences between the three conditions.

7.6.2.2. Intention for recycling

To evaluate the impact of the experimental conditions on both Recycling 1 and 2, a robust method (“nparLD” function) was chosen as both these variables were not normally distributed (see R code on the OSF for more details about the assumption checks). In the call formula, either Recycling1 or Recycling2 were set as DVs, *Condition* and *Time* were set as predictors. The participant identifier was also entered in the formula call. For both Recycling1 and Recycling2, when running both models with ABLc and Nc as reference group, no effect of *Condition* or *Time* or interaction *Condition X Time* were found significant (see Table 1).

Table 1.				
Summary of the results of the ANOVA models for the two variables representing Intention for recycling.				
		Statistic	df	p value
Recycling 1 – Model with ABLc as reference				
	Condition	1.59	1.98	0.20
	Time	2.13	1.00	0.14
	Condition:Time	1.46	1.96	0.23
Recycling 2 – Model with ABLc as reference				

	Condition	2.10	2.00	0.12
	Time	1.56	1.00	0.21
	Condition:Time	1.62	1.92	0.20
Note. The statistics reported here are ANOVA-Type Statistics As both the models with ABLc as reference and Nc as reference yield to the same statistics, we reported only one set per variables				

The robust ANCOVA's results ("lmrob" function) agrees with the results of the ANOVA: when controlling for the pre scores on intention for recycling, the post scores did not show any differences between the three conditions. Only one specific case for Recycling 2 showed that participants from the EAc had a significantly lower post intervention recycling intentions compared to those in ABLc. This result is confirmed by a visual inspection of Figure 4C.

7.6.2.3 Intention for activism

Intention for activism was set as DV, *Condition* was set as the between-subject factor variable, *Time* was set as within-subjects factor variable. The participant identifier was also entered in the formula call. The result of the type 3 ANOVA revealed no statistically significant main effect of *Condition* ($F(2, 151) = 0.57, p = .57, \eta^2 = .01$) or *Time* ($F(1, 151) = 1.80, p = .18, \eta^2 = .01$) as well as a non-statistically significant interaction between *Condition* and *Time* ($F(2, 151) = 1.98, p = .14, \eta^2 = .03$). ANCOVA's results agree with the results of the ANOVA: when controlling for the pre scores on intention for activism, the post scores did not show any differences between the three conditions.

7.6.2.4 Intention for pro-environmental behavior

Intention for pro-environmental behavior was set as DV, *Condition* was set as the between-subject factor variable, *Time* was set as within-subjects factor variable. The participant identifier was also entered in the formula call. The result of the type 3 ANOVA revealed no statistically significant main effect of *Condition* ($F(2, 151) = 0.04, p = .96, \eta^2 = .001$) or *Time* ($F(1, 151) = 0.65, p = .42, \eta^2 = .004$) as well as a non-statistically significant interaction between *Condition* and *Time* ($F(2, 151) = 0.75, p = .48, \eta^2 = .01$). ANCOVA's results, reported in §7 of Appendix B, agree with the results of the ANOVA: when controlling for the pre scores on intention for activism, the post scores did not show any differences between the three conditions.

7.6.2.5. Extra: did the conditions impact participants' artistic intentions?

Due to assumptions violation (see the R code on OSF for more information), a nonparametric version of an ANOVA ("lmrob" function) was run on two variables representing

participants' artistic intentions. The fact that participants saw either EAc (Art and Environmental Art), Nc (Art and Nature) or ABLc (Only Art), did not influence their intentions to visit a museum and see an artwork. Indeed, both effects of *Condition*, when EAc is compared to ABLc ($\beta = -0.31$, $SE = 4.81$, $t(151) = -0.06$, $p = .95$) and when Nc compared to ABLc ($\beta = -7.17$, $SE = 5.68$, $t(151) = -1.26$, $p = .21$), were not significant. Moreover, the conditions did not influence participants' intentions to buy art: Both effects of *Condition*, when EAc is compared to ABLc ($\beta = -0.38$, $SE = 4.65$, $t(151) = 0.08$, $p = .94$) and when Nc compared to ABLc ($\beta = 3.00$, $SE = 5.11$, $t(151) = 0.59$, $p = .56$), were not significant.

7.6.3. Analysis of RQ2: Does people's PEB (i.e., donation) differ across conditions?

A logistic regression was performed to assess the effects of *Condition* (a categorical variable) on the likelihood to donate a voucher (dichotomous variable: either the participant donated or did not donate). Both models with ABLc as the reference group and Nc as the reference group were computed. The models were computed with the "glm" function from the "stats" R package (cite base R). A numerical version of the donation variable was used as DV, and *Condition* was used as a predictor. In the function call, the binomial family was used.

For the model with ABLc as reference, there is a 21.79% decrease (non-significant, $p = 0.54$) in the odds to donate when the condition is EAc compared to when the condition is ABLc, and there is a 52.73% decrease (approaching significance, $p = 0.08$) in the odds to donate when the condition is Nc compared to when the condition is ABLc. For the model with Nc as reference, there is a 59.32% increase (non-significant, $p = 0.24$) in the odds to donate when the condition is EAc compared to when the condition is Nc, and there is a 103.96% increase (approaching significance, $p = 0.08$) in the odds to donate when the condition is ABLc compared to when the condition is Nc. All in all, there were no statistically significant differences between the three conditions regarding their donations. Nevertheless, when looking at Figure 4F, the following order appears: it seems that seeing artworks makes people donate more (Yes for ABLc: 29), followed by seeing environmental art (Yes for EAc: 27), followed by seeing natural environments (Yes for Nc: 21).

7.6.4. Analysis of RQ3: Can the results for the PEI (RQ1) and PEB (RQ2) be explained by the affective and cognitive properties of the images?

7.6.4.1. Did the conditions convey the expected affective (Emotions and Beauty) and cognitive states (Meaningfulness and Cognitive reflection)?

7.6.4.1.1 Whole experience. Figures 5 and 6 respectively represent the boxplot of the positive and negative emotional reactions to the whole experience (in black). Additionally, we

represented the means and 95% CI in red. All numerical data linked to Figures 5 and 6 are reported in Table S4 (§8.1 of Appendix B).

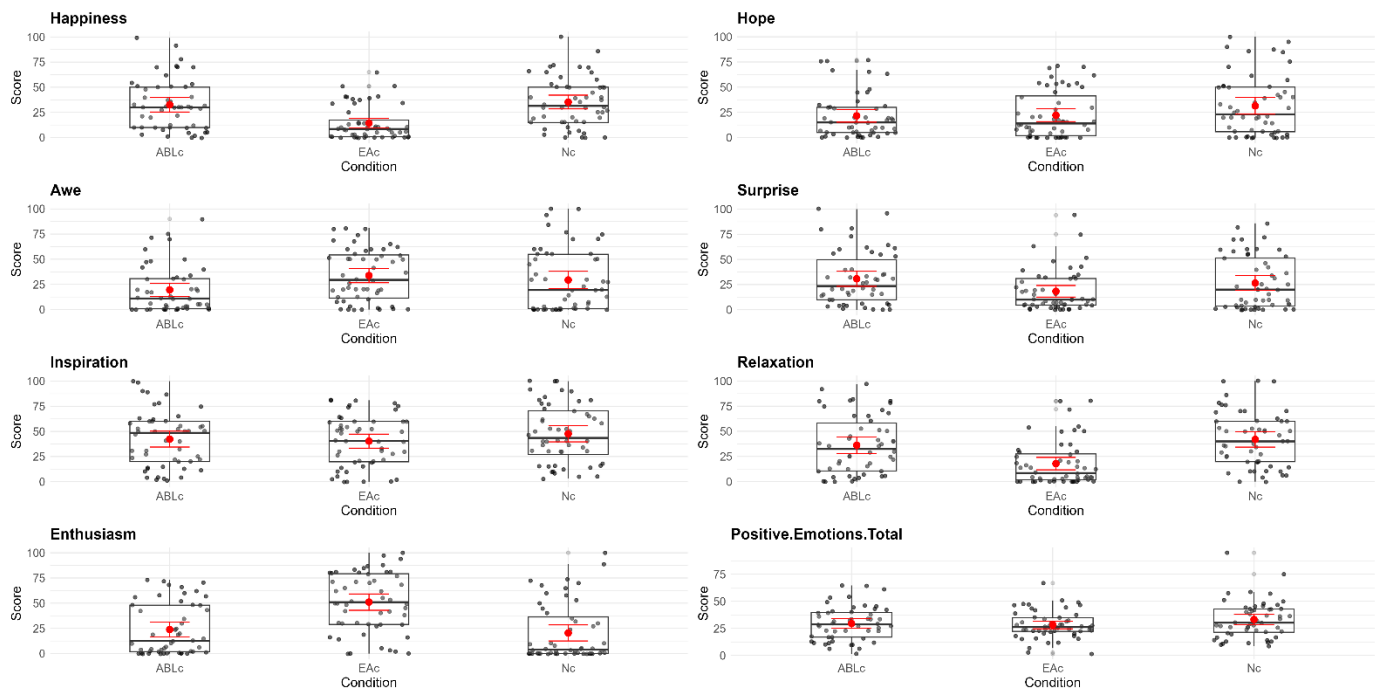


Figure 5. Descriptive statistics of the positive emotion evaluations of the whole experience.

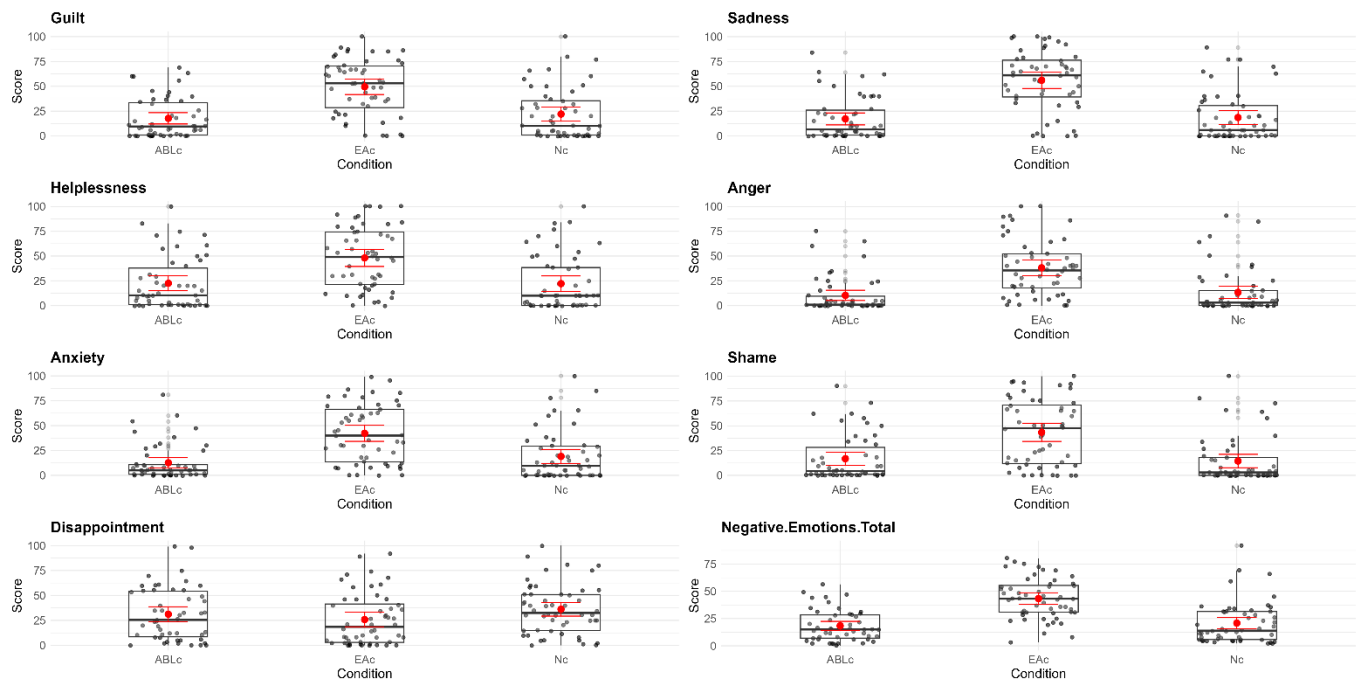


Figure 6. Descriptive statistics of the negative emotion evaluations of the whole experience.

In order to check if the three conditions had a different emotional profile, we ran two ANOVAs on the composite variables of all the positive and negative emotions (see the graph

Positive Emotions Total and Negative Emotions Total on Figures 5 and 6). Assumptions were checked (see OSF for more information), and since both variables deviated from normality, the “lmrob” function was used to assess the effect of *Condition*. No significant differences between the three conditions were found for the positive emotions. Indeed, the Positive.Emotions.Total has similar means for each condition (ABLC = 29.6, EAc = 28.3, Nc = 33.3). Yet, EAc received the lowest scores in most of the positive emotions, except for Awe and Enthusiasm (see Table S4 in §8.1 of Appendix B). On the other hand, a significant difference was found between the EAc and ABLC ($\beta = 0.26$, $SE = 3.53$, $t(151) = 7.32$, $p < .001$) and between the EAc and Nc ($\beta = 0.26$, $SE = 3.62$, $t(151) = 7.13$, $p < .001$) for Negative.Emotions.Total: the EAc was significantly associated with more negative emotions than the two other conditions. Nc and ABLC did not differ. Indeed, EAc obtained the lowest scores on all negative emotions except for Disappointment (see Table S4 in §8.1 of Appendix B).

Noteworthy, the mean for the total of all the positive emotions is very low for each condition (for ABLC, $M = 29.6$, $sd = 15.8$; for EAc, $M = 28.3$, $sd = 12.8$; for Nc, $M = 33.3$, $sd = 17.3$). Similarly, for the negative emotions (Figure 5), even if there was a substantial difference between the EAc and the other two, the average scores are generally low for each on them (for EAc, $M = 43.3$, $sd = 18.6$, with the highest score of 56 for Sadness, see Table S4 for more details).

Figure 7 displays boxplots of the three variables representing the beauty, meaningfulness and cognitive reflection evaluations of the whole experience (in black). Additionally, we represented the means and 95% CI in red. All numerical data linked to Figure 6 is reported in Table S5 (§8.1 of Appendix B).

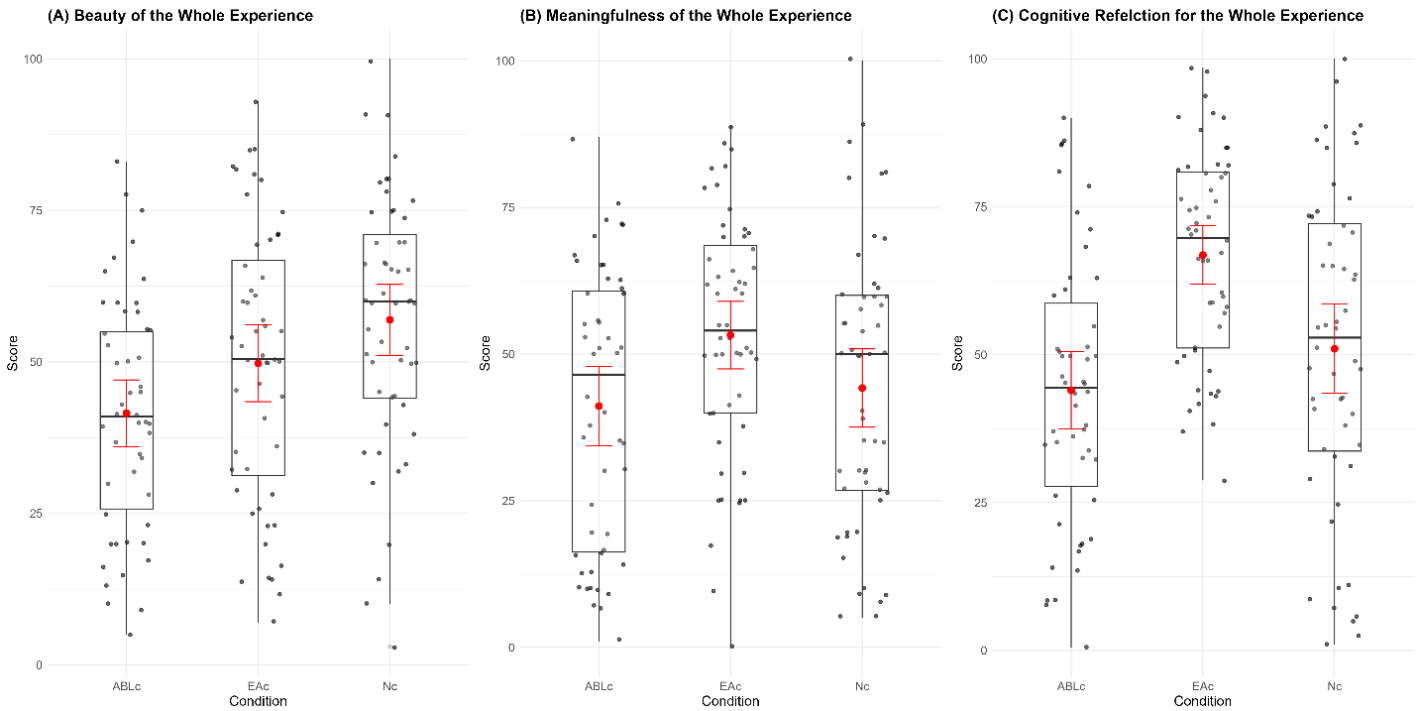


Figure 7. Descriptive statistics of the affective (Beauty) and cognitive (Meaningfulness and Cognitive reflection) evaluations of the whole experience.

After running the assumption check (see OSF for more information), a main effect of *Condition* was found for Beauty ($F(2, 151) = 6.82, p = .001, \eta^2 = .08$) for an ANOVA run with the “aov” function (R base). To unpack this main effect, a Post Hoc Analysis using Tukey's test was run with the “TukeyHSD” function from the “stats” R package (R core team citation). It revealed that only ABLc and Nc significantly differed ($p_{adj} = .001$), which is corroborated by Figure 7A.

As both Meaningfulness and Cognitive Reflection violated ANOVA's assumptions, the “lmrob” function was used to assess the effect of *Condition*. For both variables, the two models (one with ABLc as the reference group and one Nc as the reference group) were computed. For meaningfulness, a statistical difference was found between ABLc and EAc ($\beta = 12.44, SE = 4.75, t(151) = 2.62, p = .01$) and between Nc and EAc ($\beta = 10.02, SE = 4.61, t(151) = 2.18, p = .03$). No significant differences were found between Nc and ABLc. For cognitive reflection, a statistical difference was found between ABLc and EAc ($\beta = 23.49, SE = 4.31, t(151) = 5.45, p < .001$) and between Nc and EAc ($\beta = 15.24, SE = 4.88, t(151) = 3.12, p = .002$). No significant differences were found between Nc and ABLc. The higher cognitive evaluation for EAc compared the two other conditions are visually represented on Figure 7 (B and C).

7.6.4.1.2 For each image. To complement the analysis of the ratings for the whole experience, beauty and meaningfulness ratings about each image were also collected and analyzed. Figure 8 represents the means (in grey) and 95% CI (in red) on the evaluations performed after each image for the different types of images presented to the participants. Contrary to the data depicted in Figure 7 (for the whole experience), this data had the possibility to have more precise details. Hence, it was decided not to group by conditions again but rather to keep the first level of details for this analysis (evaluation per specific group of images, see the description of the content of the conditions in Figure 1). Therefore, evaluations were split according to the three different types of baseline artworks: the ones evaluated within EAc (see “Art in EAc” on Figure 8), the ones evaluated within Nc (see “Art in Nc” on Figure 7), and the ones evaluated alone within ABLc (see “ABLc” on Figure 8). All numerical data linked to Figure 8 are reported in §8.2 of Appendix B (Table S6).

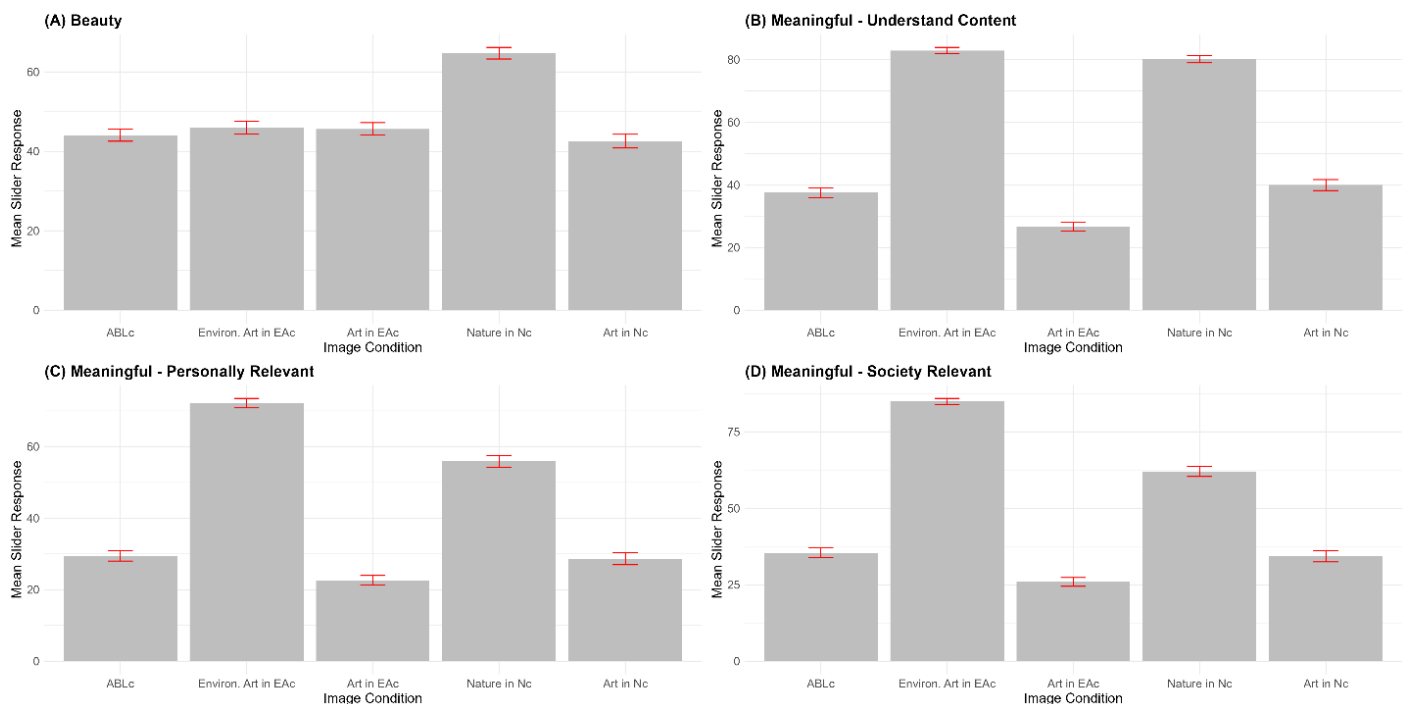


Figure 8. Descriptive statistics of the affective (Beauty) and cognitive (Meaningfulness: Understanding content, Personally relevant, and Society relevant) evaluations after each image and grouped by image type.

The baseline artworks received always lower Meaningfulness evaluations compared to the pictures of natural environment and to the environmental artworks. Though, what is interesting to note in Figure 8 is that these artworks were not evaluated the same way based on

if they were shown in EAc, Nc or ABLc (alone). Particularly, they had very similar evaluations when they were shown alone or alternated with pictures of natural environment, while their evaluations were always the lowest when they were shown with pictures of environmental artworks. Indeed, it seems that when the baseline artworks are shown alternated with environmental artworks, they were evaluated as less meaningful (for all the three Meaningfulness items) than in the other cases, i.e., when they are shown with pictures of natural environment or alone (in Figure 8, “Art in Nc” and “ABLc” have a same profile for the three variables representing meaningfulness, while “Art in EAc” is always lower). This means that the baseline artworks directly presented with environmental artworks tend to lose their meaningfulness. This effect is not visible for Beauty, as “ABLc”, “Art in EAc” and “Art in Nc” have the same profile. Note that a similar effect to the one found on Figure 7A is visible: it seems that people find the pictures of natural environment more beautiful.

For the inferential investigation dedicated to see if our manipulation check worked, it was decided to recreate the full EAc and Nc (i.e., respectively merge the “Art in EAc” and “Art in Nc” back with the environmental artworks and the pictures of nature). Figure 9 shows the means (in grey) and 95% CI (in red) on the evaluations performed after each image for the three conditions. All numerical data linked to Figure 9 are reported in Table S7 (§8.2 of Appendix B).

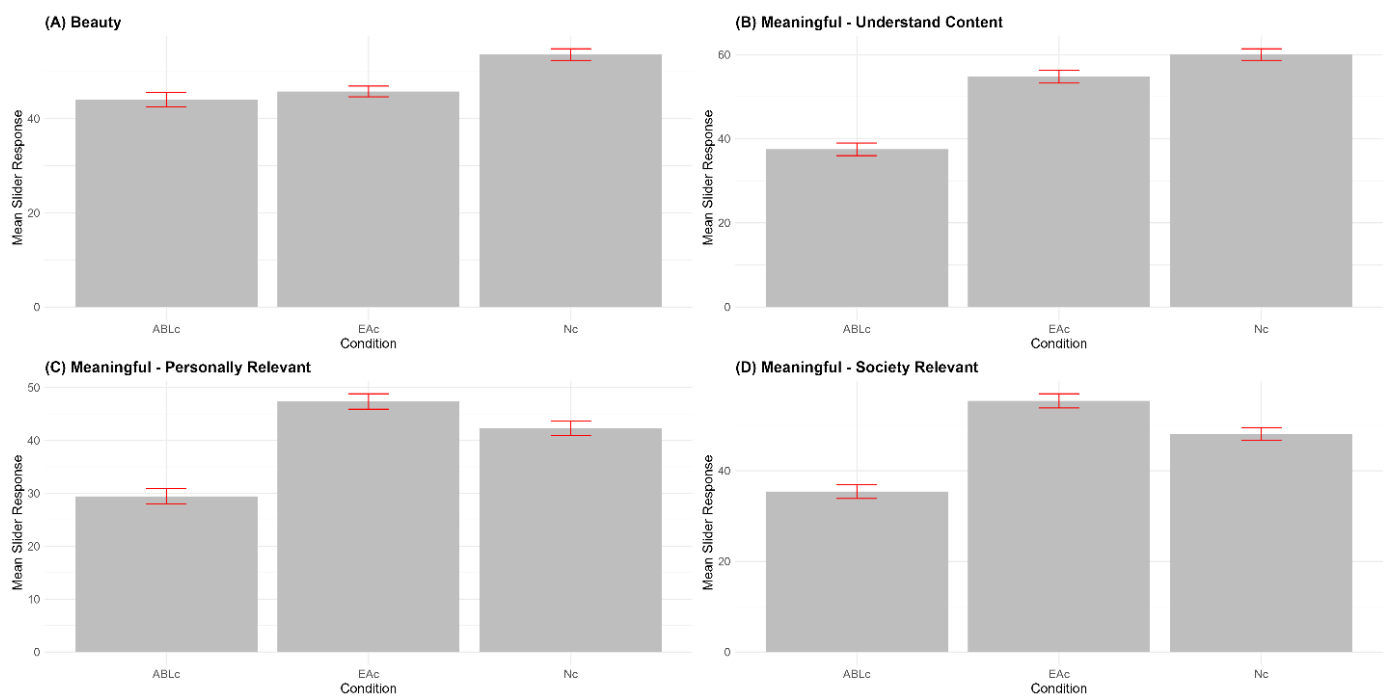


Figure 9. Descriptive statistics of the affective (Beauty) and cognitive (Meaningfulness: Understanding content, Personally relevant, and Society relevant) evaluations after each image and grouped by conditions.

Assumption check for all the variables revealed that all four variables were not normally distributed (see the R code in OSF for more information). The “lmrob” function was thus used to assess the effect of Condition. For all four variables, the two models (one with ABLc as the reference group and one Nc as the reference group) were computed. Results are reported in Table 2. Similar to the evaluation for the whole experience, Nc was found to be significantly more beautiful than ABLc and EAc. ABLc and EAc did not differ. Interestingly and contrary to the meaningfulness and cognitive reflection of the whole experience, participants did not find EAc to be the most meaningful in terms of understanding the content. Indeed, Nc was significantly easier to understand than ABLc and EAc. Nevertheless, EAc was significantly easier to understand than ABLc. Finally, the meaningfulness in terms of Personal and Societal relevance had similar profiles than the cognitive reflection of the whole experience: EAc had significantly higher scores than ABLc and Nc. The only difference between these evaluations and the ones from the whole experience is that a significant difference was found between Nc and ABLc, with Nc being more personally and societally relevant for the participants in the ABLc.

Table 2.					
Summary of the results of the ANOVA models for the cognitive and affective evaluations after each image					
		Estimate	SE	T value	P value
Beauty – Model ABLc as reference					
	Condition Releveled EAc	1.7	1.04	1.64	0.1
	Condition Releveled Nc	10.27	1.08	9.49	<2e-16 ***
Beauty – Model Nc as reference					
	Condition Releveled EAc	-8.57	0.94	-9.15	<2e-16 ***
	Condition Releveled ABLc	-10.27	1.08	-9.49	<2e-16 ***
Meaningfulness Understanding content – Model ABLc as reference					
	Condition Releveled EAc	18.44	1.27	14.67	<2e-16 ***
	Condition Releveled Nc	24.24	1.16	20.89	<2e-16 ***
Meaningfulness Understanding content – Model Nc as reference					
	Condition Releveled EAc	-5.80	1.21	-4.796	1.67e-06 ***
	Condition Releveled ABLc	-24.24	1.16	-20.89	<2e-16 ***
Meaningfulness Personally relevant – Model ABLc as reference					
	Condition Releveled EAc	18.55	1.15	16.10	<2e-16 ***
	Condition Releveled Nc	12.97	1.06	12.18	<2e-16 ***
Meaningfulness Personally relevant – Model Nc as reference					
	Condition Releveled EAc	5.57	1.13	4.93	8.5e-07 ***
	Condition Releveled ABLc	-12.97	1.06	-12.19	<2e-16 ***
Meaningfulness Society relevant – Model ABLc as reference					
	Condition Releveled EAc	21.41	1.29	16.59	<2e-16 ***
	Condition Releveled Nc	13.33	1.14	11.72	<2e-16 ***

Meaningfulness Society relevant – Model Nc as reference					
	Condition Releveled EAc	8.08	1.23	6.55	6.27e-11 ***
	Condition Releveled ABLc	-13.33	1.14	-11.72	<2e-16 ***

7.6.4.2. Conclusion: did the conditions convey the expected affective (Emotions and Beauty) and cognitive states (Meaningfulness and Cognitive reflection)?

Evidence from both the evaluations made on the whole experience (see Figure 7) and after each image (see Figure 9) show quite distinct profiles for the three conditions. EAc, except for the Understanding Content item, is the condition that has the highest scores for all the cognitive aspects of the aesthetic experience. In most cases, this condition is significantly higher than the two other ones. When looking at emotions, EAc has a significant association with negative emotions. Nc is the condition that participants found the most significantly beautiful (affective aspect of the aesthetic experience) compared to the ABLc, for both the whole experience and the individual image evaluations. Nc was also found to be significantly more beautiful than EAc for the individual image evaluation. Interestingly, Nc is not significantly evoking more positive emotions. ABLc consistently obtained the lowest ratings for beauty, meaningfulness and cognitive reflection, and it was always significantly lower than the category that had the highest score for each evaluation. No emotional profile emerged for ABLc.

All in all: (1) EAc is cognitively engaging, and it prompts negative affective processes; (2) Nc is engaging the affective process but only the beauty (no emotional attachment); (3) ABLc, when compared to EAc and Nc, seem to not have any specific cognitive (meaningfulness, cognitive reflection) and affective (beauty and emotions) profile.

7.6.4.3. Exploratory correlations among the variables

Figure 10 displays three correlation matrices for the six main variables of interest (PEI and PEB) and five variables representing the cognitive (Meaningfulness and Cognitive Reflection) and affective aspects (Beauty, Positive and Negative emotions) of the aesthetic experience that were collected for the whole experience. Each matrix is dedicated to the results of each of the conditions. Within each matrix, a Bonferroni correction was applied to determine the significant threshold (0.05/55, 55 being the number of comparisons within the matrix).

For each of the conditions, none of the six main variables of interest significantly correlated with the five variables representing the cognitive and affective aspect of the aesthetic experience. This indicates that the properties of the stimuli do not seem to influence people's intentions and behavior. Nevertheless, we note that some of the variables representing the aesthetic experience significantly correlate. In all conditions, Cognitive Reflection is

significantly correlated with Meaningfulness and with Negative Emotions. For EAc and Nc, Beauty and Positive emotions are significantly correlated. Finally, there are two specific correlations that differentiate EAc from Nc: in the former, Meaningfulness is significantly correlated with Negative Emotions, whether in the latter, is related with Positive Emotions.

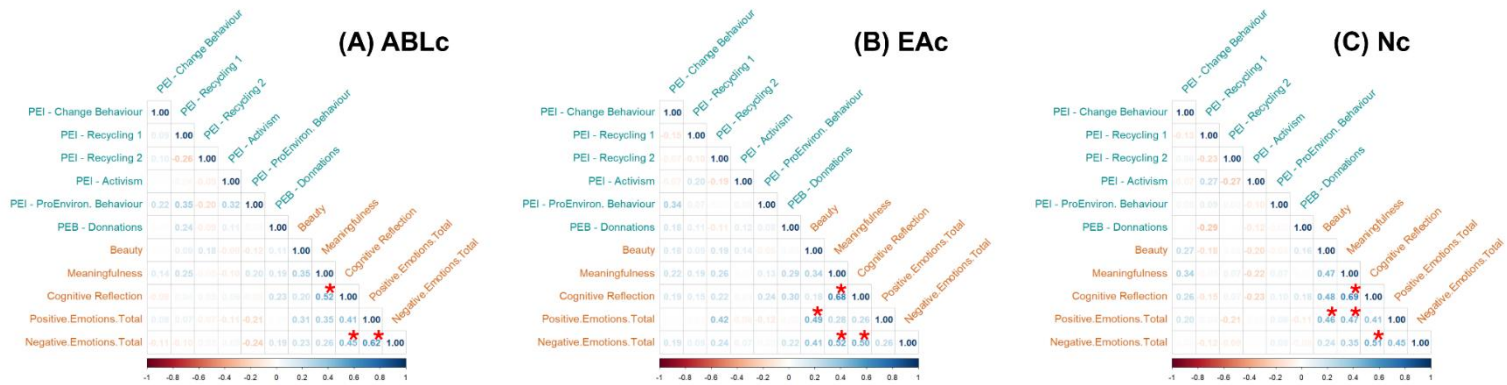


Figure 10. Correlation matrices between the six main variables of interest and five variables representing the and affective aspect of the aesthetic experience for the three Conditions.

7.6.5. Analysis of RQ4: Can the results for the PEI (RQ1) and PEB (RQ2) be explained by individual differences among participants?

7.6.5.1. General overview of the variables

Figure 11 displays boxplots of the eleven variables evaluating participant traits (in black). Additionally, we represented the means and 95% CI in red. All numerical data linked to Figure 11 are reported in Table S8 (§9.1 Appendix B). What stands out the most from this analysis is the very low score for the NEP ($M = 29.6$, $sd = 9.22$) and for the VAIK ($M = 4.01$, $sd = 1.16$), as well as the very high scores for Attitude.Recycle ($M = 91.06$, $sd = 13.44$).

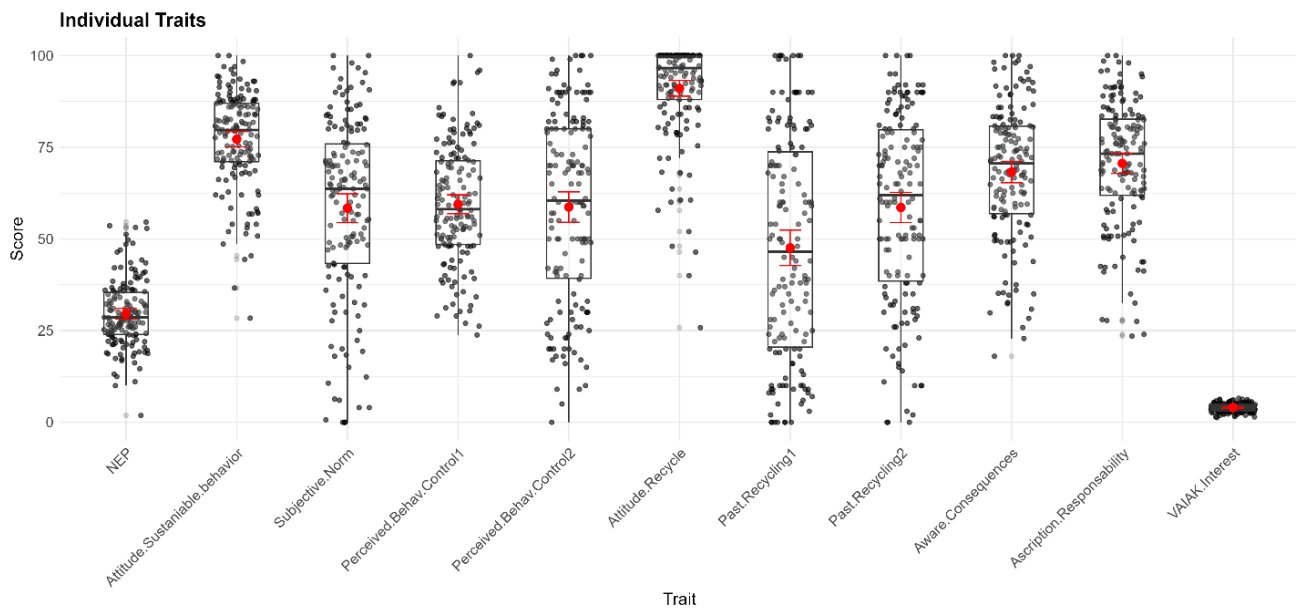


Figure 11. Descriptive statistics of the eleven variables evaluating individual traits (not split according to the three Conditions).

Moreover, although no effect of Condition was found on the main variables of interest (PEI and PEB), we checked if any of the scores obtained on the individual trait variables would significantly differ across conditions. As a first step, the individual traits were split into the three Conditions (see Figure 12, and Table S9 in the Appendix B for numerical data associated with the figure), and we investigated if the participant from the different conditions had a similar individual trait profile. To do so, three parametric ANOVAs (for NEP, PerceivedBehavControl1 and VAIK Interest) and eight non-parametric ANOVAs were run (see the R code for the assumption check). The results are summarized in Table 3. Results show no significant differences between the three conditions: the three samples are composed of similar individuals (for the individual traits tested).

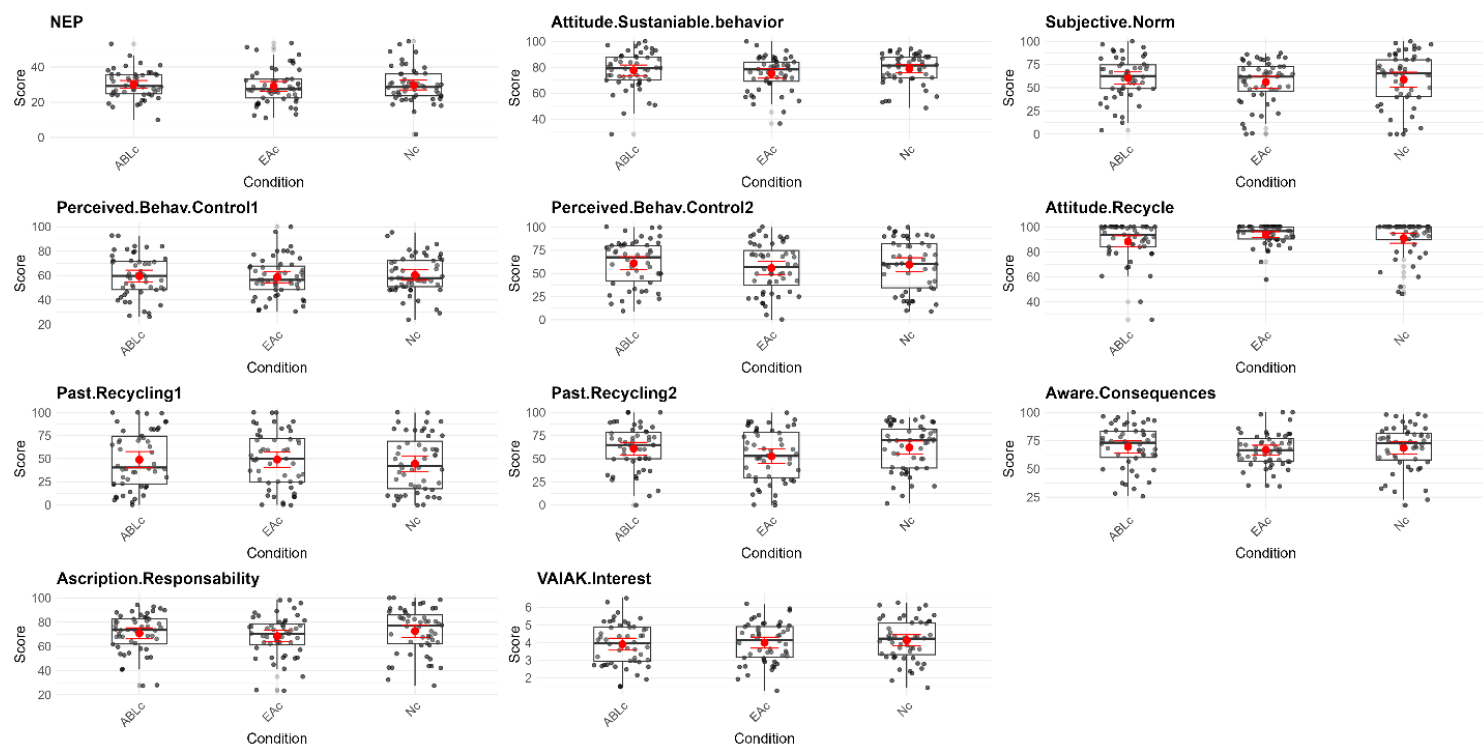


Figure 12. Descriptive statistics of the eleven variables evaluating individual traits (split according to the three Conditions).

Table 3.					
Summary of the results of the ANOVA models for the eleven variables assessing participants' individual traits					
		Estimate	SE	F value or T value	P value
ANOVA – NEP					
	Condition			0.18	0.84
ANOVA – Perceived Behav. Control1					
	Condition			0.15	0.86
ANOVA – VAIKAK Interest					
	Condition			0.45	0.64
AttitudeSustani – Model ABLc as reference					
	Condition Releveled EAc	-3.01	2.61	-1.15	0.25
	Condition Releveled Nc	0.4	2.45	0.16	0.87
AttitudeSustani – Model Nc as reference					
	Condition Releveled EAc	-3.4	2.36	-1.44	0.15
	Condition Releveled ABLc	-0.4	2.45	-0.16	0.87
SubjNorm – Model ABLc as reference					
	Condition Releveled EAc	-3.65	4.53	-0.81	0.42
	Condition Releveled Nc	0.29	5.5	0.05	0.96
SubjNorm – Model Nc as reference					

	Condition Releveled EAc	-3.94	5.35	-0.77	0.46
	Condition Releveled ABLc	-0.29	5.49	-0.05	0.96
PerceivedBehavControl2 – Model ABLc as reference					
	Condition Releveled EAc	-5.4	5.42	1	0.32
	Condition Releveled Nc	-1.5	5.58	-0.27	0.79
PerceivedBehavControl2 – Model Nc as reference					
	Condition Releveled EAc	-3.91	5.67	-0.69	0.49
	Condition Releveled ABLc	1.5	5.58	0.29	0.79
AttitudeRecycle – Model ABLc as reference					
	Condition Releveled EAc	0.45	1.87	0.24	0.81
	Condition Releveled Nc	2.4	1.86	1.29	0.2
AttitudeRecycle – Model Nc as reference					
	Condition Releveled EAc	-1.95	1.03	-1.89	0.06
	Condition Releveled ABLc	-2.41	1.86	-1.29	0.2
PastRecycling1 – Model ABLc as reference					
	Condition Releveled EAc	0.45	6.53	0.07	0.95
	Condition Releveled Nc	-4.29	6.57	-0.65	0.51
PastRecycling1 – Model Nc as reference					
	Condition Releveled EAc	4.74	6.34	0.75	0.46
	Condition Releveled ABLc	4.29	6.57	0.65	0.51
PastRecycling2 – Model ABLc as reference					
	Condition Releveled EAc	-8.52	5.49	-1.55	0.12
	Condition Releveled ABLc	1.58	5.04	0.31	0.75
PastRecycling2 – Model Nc as reference					
	Condition Releveled EAc	-10.1	5.62	-1.8	0.074
	Condition Releveled ABLc	-1.58	5.04	-0.31	0.75
AscripResponsa – Model ABLc as reference					
	Condition Releveled EAc	-2.46	3.16	-0.78	0.44
	Condition Releveled Nc	1.98	3.52	0.56	0.58
AscripResponsa – Model Nc as reference					
	Condition Releveled EAc	-4.44	3.58	-1.24	0.22
	Condition Releveled ABLc	-1.98	3.52	-0.56	0.58
Aware Consequences – Model ABLc as reference					
	Condition Releveled EAc	-4.49	3.73	-1.21	0.23
	Condition Releveled Nc	-0.48	4.01	-0.12	0.91
Aware Consequences – Model Nc as reference					
	Condition Releveled EAc	-4.01	3.6	-1.12	0.27
	Condition Releveled ABLc	0.48	4.01	0.12	0.91

7.6.5.2. Exploratory correlations among the variables

Figure 13 reports three correlation matrices (one for each condition) between the six main variables and the eleven variables that assess participant's trait variables. Within each matrix, a Bonferroni correction was applied to determine the significant threshold (0.05/136, 136 being the number of comparisons within the matrix). Figure 13 shows that there are some correlations among trait variables (which is expected), but there are not significant correlations between the trait variables and intentions or donations.

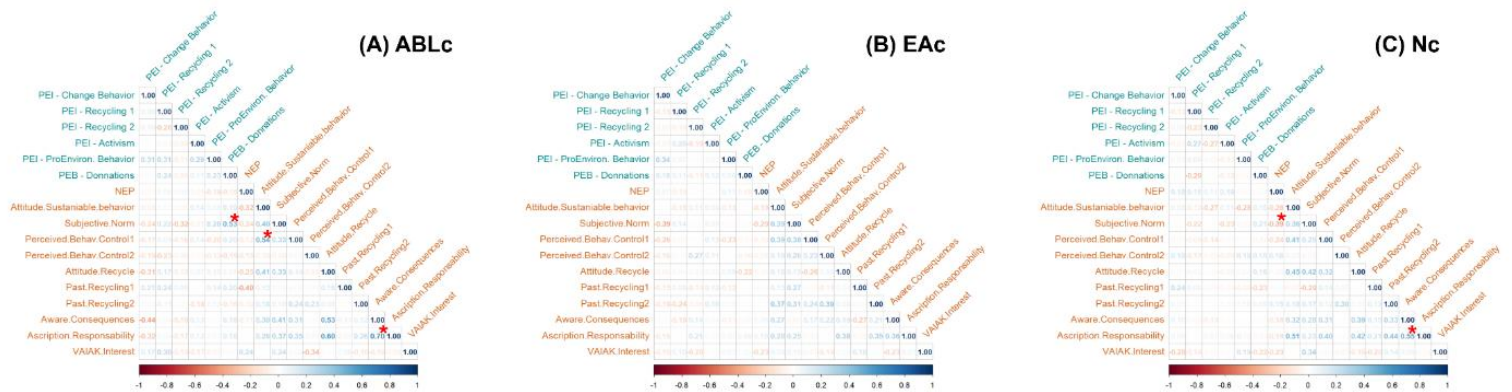


Figure 13. Correlation matrices between the six main variables of interest and eleven variables evaluating the participants individual traits for the three Conditions.

7.7. Discussion

In the present study we investigated the role of visual environmental art in encouraging pro-environmental intentions (PEI) and behavior (PEB). To do so, images of artworks installations made of plastic waste and placed within a natural environment were used, and we compared the responses to these stimuli with those elicited by images of the same natural context without the artistical component, as well as images of other artworks not related to environmental issues nor nature. Specifically, the study had two main goals: (a) to investigate the effects of these visual stimuli on environmental intentions and behavior, and (b) which could be the psychological mechanisms that would eventually guide these effects.

In regard to the first goal (a), we measured pre-and-post-exposure intentions in favor of the environment through validated self-reports, specifically: intentions to change behavior in terms of consuming, recycling, activism, and for PEB (here related to the willingness to act in favor of the environment). Furthermore, we checked if the exposure would have any immediate

effect on behavior, giving the chance to donate a 100€ lottery ticket to an environmental association at the end of the experiment. Consequently, two of the study's research questions concerned whether there would be any difference across conditions in (RQ1) our pre-and-post intentions variables, and (RQ2) in donations. In relation to these research questions, we did not find any significant differences.

With regards to the second goal (b), we measured several different variables in relation to: the affective and cognitive responses to the stimuli, and the individual traits in respect to the natural environment and its protection. Specifically, we focused our investigation on beauty and emotions (either negative and positive) as affective influence, and on meaningfulness and reflection as cognitive influence. Accordingly, the other two research questions of the study concerned whether any effect could be explained by (RQ3) the cognitive or the affective responses to the stimuli and to the whole experience, or by (RQ4) the individual differences in the relation with the environment. Since we did not find any effect, we cannot provide any positive answers to these questions. Nevertheless, significant differences were found in respect to the affective and cognitive responses to the stimuli. Given the results obtained in the individual traits variable, these findings can provide interesting and useful insights. Interpretations of these findings as well as limitations of the study and acknowledgements for future developments are discussed.

7.7.1. Influence of environmental art on PEI and PEB

7.7.1.1. PEI

Concerning the Pro-Environmental Intentions (PEI) variables, we did not find any significant results. Nevertheless, even if not significantly, the scores on the post-exposure measurements are almost always higher than the pre-exposure for the EAc (see details in Table S1 in the Appendix). This is true except for Recycling2. Indeed, for this latter, the ANCOVA's results (but not the ANOVA's) showed that participants of the EAc had significantly lower post-intervention recycling intentions, compared to those of the ABLc. A possible explanation of this result could be related to the unexpected low scores that this variable registered on the post-measurements for the EAc, which instead collected high positive scores on all the other variables, including Recycling1. The difference of Recycling2 in respect to Recycling1 is that the responses to the former ("How likely will you recycle cans, bottles and paper on a fortnight basis?") had inverted labels (0 - "highly likely", 100 - "highly unlikely"). Since most of the answers had not inverted labels, it is possible that participants did not pay attention to this inversion, resulting in an erroneous assessment.

Generally, in regard to the lack of results, one reason could be assigned to the method of measurements. We used self-reports to measure intentions which, in line with our theory of reference (i.e., TPB), are meant to be a strong predictor for behavior (Ajzen, 1985). Intentions can be the indirect manner through which attitude influences behavior (Bagozzi, 1981), and surveys can play an important role in this process (Chandon et al., 2005). Though, we know that these models explain only between 50-20% of the variance in intentions and behavior (Sutton, 2006), and that notably environmental behavior has among its challenge the intention-behavior gap (Sheeran & Webb, 2016; Evans et al., 2017).

Another reason could be related to the type of media used. The use of images may not be as powerful as other forms of communication such as videos or documentaries, and this could result in a weaker affective engagement, as well as in reduced likability and perception of beauty. One way to increase this, for instance, could be to provide descriptive information about the artwork and the artist, an element which is known to increase the evaluation of beauty (Darda & Chatterjee, 2023; Castellotti et al., 2023; Gerger & Leder, 2015; Swami et al., 2013) and in turn lead to a more intense affective and cognitive involvement (Leder et al., 2004, 2014). Recently, beneficial effects of additional information have been found also for digital artworks experienced on a screen (Castellotti et al., 2024). Indeed, a further development of this study tested the same stimuli with or without the addition of descriptions about the artists and the artworks (see Study 5, Chapter IX).

All in all, trends emerging from the data may suggest that a possible effect could be perhaps achievable, and we believe that a lack of significant effects could be due to the stimuli not being too powerful (because of their format or the experimental context) rather than to specific methodological issues (such as sample size or measurement choices).

7.7.1.2 PEB

As for PEI, concerning Pro-Environmental Behavior (PEB), no significant results were found. Measuring PEB has its strengths and weaknesses (Lange & Dewitte, 2019; Klockner, 2013). To find the psychological correlates of a specific behavior, it should be crucial for PEB to be accurately assessed, which is one of the limits that sometimes mines the validity of self-report measures (Gifford, 2014; Lange, Steinke, & Dewitte, 2018). For this reason, rather than self-report, we decided to measure an immediate effect on PEB by the willingness to donate.

Figure 4 (§7.6.1.1) shows that, even if not significantly, the ABLc registered the most donations, followed by the EAc and finally Nc. Surprisingly, the condition with most donations was in fact the only one not related to the environment. Though, this is not the only case where

we can notice this trend, which could possibly represent a hint for the lack of findings. Indeed, “Attitude toward Recycling” and “Intentions for Recycling1” are the variables that registered overall the highest scores, respectively within the trait and the intention variables, and they both obtained the highest scores in the ABLc, the one where we had the most donations. Further, ABLc is also the condition with the most correlations among trait variables (see Figure 13). This trend might suggest that, in our case, rather than an influence of the stimuli, results on intentions and donations might instead be more strongly related to individual traits. In this view, considering the low scores in the NEP, the not high propensity to donate could be related to the general weak ecological worldview¹³: indeed, if the emotional impact is not strong enough to induce a sort of change, our decision will hold on to our beliefs, and it is possible that this was exactly the case (more details in §7.7.3).

Another argument for the lack of results could be evidently related to the experimental setting. The present study aimed at investigating an aesthetic experience through images shown on a screen in the laboratory. Although our investigation concerned specifically the type of context in which people experience this art, which happens mostly individually on a screen (i.e., through social media and/or news-websites were possibly it is also given the chance to donate in favor of an environmental project), yet, the experimental setting of a laboratory is not equivalent to a private room or intimate personal place, which would be a more realistic (and probably inspiring) setting for this kind of situations. Eventually, future studies could replicate the present design online, and check if the same kind of experience in a more private space (e.g., at home) would bring different results.

Finally, the sample and the context of this study (i.e., mostly University students, based in Vienna) may not have favored the emergence of an effect in relation to plastic waste issues and donations. Indeed, the plastic problem is probably less severe in Austria (Plastic Atlas, 2019; Van Eygen et al., 2017) compared to other European countries like Italy (Plastic Europe, 2024; Campale et al., 2019; Paletta et al., 2019; Leal Filho et al., 2019), and the distance from people’s everyday personal experience may result, indeed, in weak emotional engagement (Leiserowitz, 2006; Weber, 2006). In addition, students’ willingness to make monetary donations may depend on several factors such as parental support or scholarship (Freeland et al., 2015), and they may be reluctant to give up on their lottery ticket (Bar-Hillel & Neter, 1996; Rasen & Gilovich, 2007). Notwithstanding, data show that donations in experiments are

¹³ Note that the NEP is often used as a measure for general environmental attitude, but it represents also values orientations and personal norms: see Klockner, 2013 (p.1030).

correlated with behavior in the field (Benz & Meier, 2008), which allows researchers to use this measure for prosocial and pro-environmental behavior. All in all, we believe that to better understand how to find possible correlation between donations and exposure to images in this specific field (i.e., environmental art), more investigations are needed.

7.7.2. Influence of the affective and cognitive aspects of the aesthetic experience

Although we found no significant effect of the conditions over PEI and PEB, the results obtained for the variables measuring the cognitive and affective aspects of the aesthetic experience still provide interesting insights. In relation to the evaluation of the whole experience, the EAc was rated significantly more meaningful and cognitively reflective than the other two, while the Nc was rated significantly more beautiful than the ABLc, as it is shown in Figure 7 (§7.6.5). This trend is replicated in the scores obtained on these same components evaluated for the single images (Figure 8 and 9), with the only difference that, in this case, the images of nature were rated as significantly more beautiful not only in comparison with the ABLc images, but also compared to the environmental artworks.

Furthermore, in regard to the emotional response to the whole experience, Figure 6 shows how the EAc was more associated with almost all the negative emotions (except for “disappointment”) if compared to the other two, which makes it significantly more emotionally negative in total (§ 7.6.4.2.). This allows us to consider it as an emotionally negative valence condition. Conversely, this overall difference (all emotions averaged together) is not replicated in the positive emotions’ responses (Figure 5), where there is no significant general difference across the three conditions (Happiness, Surprise, and Relaxation are the only variables where the mean of the EAc is lower than the other two; more details in the Table S4, §8.1 in Appendix B). Finally, the correlations between these variables (Figure 10) show that, in the EAc, Meaningfulness is significantly related to negative emotions, whereas in the Nc it is with positive emotions.

All in all, these results confirmed our manipulation check. Specifically, they show how the conditions differ significantly in terms of affective and cognitive factors. Indeed, comparing the EAc and the Nc, it produced a significant comparison between meaningful and emotionally negative stimuli from one side, and beautiful-positive stimuli on the other. This indicates that the lack of significant differences across conditions cannot be attributed to an alleged similarity between them.

Further, what is also relevant to notice about the affective responses, is the averagely low scores in the emotional variables (see § 7.6.4.1). Therefore, the EAc induced significantly negative emotions and cognitive reflecting, but the emotional engagement of the experience was generally weak. Our findings are in line with previous studies that showed a significant correlation between negative emotions and deep cognitive reflection on the artworks (Sommer & Klockner, 2021; Sommer et al., 2019; Blasch & Turner, 2016). Although some negative emotions can be detrimental to decision-making (O'Neill & Nicholson-Cole, 2009; Bechara and Damasio, 2005), others, such as guilt (Rees et al., 2015) or anxiety (Ogunbode et al., 2022) can motivate pro-environmental behavior. Meaning-making, in turn, is one of the key components that emerges throughout most of the art-viewing perception models (Leder et al., 2004; Leder & Nadal, 2014; Pelowski et al., 2016; Pelowski et al., 2017), and it can bring re-framing of attitudes and beliefs (Knizek et al., 2021). However, the overall emotional engagement of the environmental artworks was generally weak, as well as the evaluation of beauty. Therefore, the Environmental art condition, although cognitively engaging, might have lacked a strong enough emotional and affective reaction to induce an actual effect on action. We believe that further studies should try to stress those emotions we found most predominant, and test whether a combination of cognitive and deeper emotional involvement could bring different results.

7.7.3. Influence of the individual traits

Finally, in regard to the trait variables that we measured, an answer for RQ4 cannot be provided, since we did not find any significant effect on PEI and PEB. Nevertheless, none of the trait variables significantly differ across conditions, meaning that there were not significant individual differences in our sample in relation to those factors. Hence, the lack of findings cannot be explained by individual differences between the three groups (conditions).

Crucially, among all the variables, it is important to highlight two results. As shown in Figure 11, we registered generally very low scores on the NEP, and extremely low scores on the part1 (art interest) of the VAIK (see §7.6.5.1). This means that our participants had overall a scarce ecological worldview, and that they were not interested in art at all. These two findings represent crucial insights into the interpretation of our results. Indeed, considering the lack of interest in art, the significant meaningfulness of the environmental artworks highlights the cognitive power of those stimuli/images. The unexpected low scores on the NEP, in turn, reinforce our line of interpretation for which the responses to the main investigation variables

(intentions and donations), due to the not so powerful emotional involvement of the experience, seem to be related to the individual traits rather than to the kind of stimuli to which participants were exposed (see §7.7.1.2). Indeed, this interpretation is in line with other previous findings: in Zelenski et al. (2015), for instance, exposure to target videos (nature documentary) increased pro-environmental donation behavior only in those already having a strong sense of connectedness with nature. Klockner & Sommer (2021), in turn, found that reflection on the artwork was significantly related to support for climate policy only for those participants who had weak environmental attitude. As in regard to art interest, Sommer et al. (2019) found that experience with art increased changes in intention.

All in all, our findings need to be interpreted in light of these two important features (low scores in NEP and VAIK). To encourage pro-environmental behavior through art with this kind of profile is probably the most ambitious purpose, as well as the greatest challenge. The present study provides evidence that, under these circumstances, the understanding and reflection on the content's message may not be enough to induce a significant change in intentions and behavior, and that a strong emotional and affective involvement is probably crucial for cognitive reflection to induce behavioral change through art (Klockner & Sommer, 2021).

7.8. Conclusions

The resolution of environmental issues such as the production and accumulation of plastic waste will be on top of most Countries' political agendas for the next decades. Individual behavior plays a crucial role in this, and most of the population should be conscious of that. Yet, individual actions taken in favor of the environment are still insufficient. It is commonly believed that art can play an important role in this, and many artists are devoted to spread awareness and inducing behavioral changes through the impact of their creations.

From a psychological perspective, we know that an aesthetic experience is a dynamic interplay between cognitive and affective components (Leder et al., 2004; Leder & Nadal, 2014; Pelowski et al., 2017), where the degree and the power of these features (e.g., beauty and meaningfulness) should assess what differentiates it from other kinds of ordinary mundane experience (Shusterman, 1997). In the present study, the types of environmental artworks shown have produced a meaningful experience, demonstrating that art may create a narrative through which the receiver engages with high levels of reflection and understanding of the message. Though, there was not a similar engagement in terms of beauty and emotions.

We showed images on a screen and asked for the willingness to make a donation, which represents a realistic case of experiencing these specific types of artistic projects (i.e., artists creating such artworks in nature and spread them as digital images through internet), as well as a way artists and associations may use to ask people for actions in favor of the environment. Our investigation shows that, even if meaningful, this modality of use for art to encourage pro-environmental behavior could not be effective enough on a sample of the population which is not interested in art and not much concerned about the environmental crisis. Specifically, it seems that, without a puissant emotional engagement, receivers' decisions are not influenced by external stimuli but are rather correlated with their individual traits such as values and beliefs.

Regarding the role of art in encouraging pro-environmental intentions and behavior, this study shows evidence that the use of digital images of environmental artworks may not produce the effect that they are expected to have, at least for the case study that we investigated (i.e., plastic waste artistical installations experienced in the laboratory). In this sense, the enormous and costly work that most artists do in order to raise awareness of environmental global issues and to encourage people's action remains perhaps more emphasized and efficient when it is widespread through other digital forms (e.g., videos, documentaries), so as to produce the deserved impact it is supposed to have.

We hope that our study can bring some new insights into the affective and cognitive processes related to this specific type of art experience, as well as future directions that could be taken for both scientists and artists.

PART III

**REPORT OF THE COLLABORATION WITH
KILOWATT, PARTNER COMPANY OF THE
PROJECT**

My PhD project is part of the National Operational Program (PON) Research and Innovation 2014-2020, specifically within the category of “Doctorates on Green Themes” (Action IV.5 of the Program). The scholarship envisaged six months of collaboration with a company which carries out activities within the environmental sustainability area and in relation to the same local territory of the University of reference (i.e., Bologna). This particular type of scholarship is funded in collaboration with the European Union and the Italian Ministry of University and Research, with the aim to solicit and create fruitful partnerships between local community projects and the academic institutions, i.e., the “Third Mission”, namely the set of activities through which universities directly interact with society, in any research field. Regarding my project, the partnership concerned the application of cognitive science’s empirical methods outside the academic walls, hence, fostering more ecological research that can be implemented outside the laboratory and applied to actual activities of the local territory, specifically in relation to environmental sustainability.

The partner company of our project was the Cooperative Society “Kilowatt”. Kilowatt is a cooperative that works in social innovation, circular economy, communication, and urban regeneration¹⁴. It is based on a sustainable and innovative public-private partnership model, since it aligns the objectives of the public administration to those of the private sector around a project with a sustainable business model. This project comes to life in the regenerated spaces of “Le Serre dei Giardini Margherita” (the Greenhouses placed inside the wonderful park of Giardini Margherita in Bologna), a place for culture and new model testing.

The partnership thus concerned the implementation of studies in which we could intersect the focuses of my doctoral project with some of the company's areas of work. The aim then was to actualize and accomplish research that could be functional and enriching for both parties. Indeed, this is what came out of this partnership. In the period of collaboration (six months), two different studies were developed. In accordance with the company's availability (which had a renovation work already scheduled for 2024), we have organized the collaboration into two distinct periods: from September 1st 2023 to November 14th the first period, from May 16th 2024 till August 31st the second.

In the first study (here referred as Study 4 – “Aesthetic Experience and Space”, Chapter VIII), our methodologies and analysis tools have been applied to provide Kilowatt with new understanding and perspectives on their activity, providing quantitative and qualitative data

¹⁴ <https://kilowatt.bo.it/en/about/>

about specific interventions to be done in order to implement the sustainability of their place. Indeed, sustainability does not concern only objects and people (i.e., the two key elements investigated in relationship to sustainability in the other studies reported in the present thesis), but also spaces. Specifically, our objective concerned the investigation of the spatial communication and navigation of the company headquarters' green space (i.e., the whole outdoor space of the Greenhouses) in relation to the way people achieve learning of sustainable practices and knowledge by experiencing, moving, and passing through that place. At the time of the initial implementation of the study, Kilowatt was working on a renovation of the spatial communication of their entire outside space, with the aim to improve its frequenters' knowledge about their spaces and activities, and thus consequentially encouraging to behave in respect to the sustainability of the place. Thuse, Study 4 – “Aesthetic Experience and space” originally entangles sustainability, aesthetics of space, perception of objects (i.e., communication landmarks), and participants' behavior in a green real (ecological) space. The study envisaged two different moments of investigation, respectively before and after the renovation (i.e., the implementation of a new set of communicative landmarks). The second part was supposed to be made in the second period of collaboration, upon my return from the period of visiting abroad spent at the University of Vienna (in which Study 3 was done). However, the company did not complete the implementation in time. Therefore, due to the delay in their work, it was not possible for us to complete the study, and the report in the present thesis (Chapter VIII) concerns the data collection, analysis, and results of the first part.

Consequently, in the second period of my collaboration with the company we decided to implement a new experiment which could represent the most coherent development of my project carried out up to that moment, and so we designed a follow up study of the one I had just completed in Vienna (i.e., Study 3). We organized this experiment according to Kilowatt's agenda and their availability for their space to set up a laboratory. The collection of this data is then the outcome of the last months of collaboration with the company, in which I tested participants on site (in the Greenhouses of Giardini Margherita) depending on the availability and usability of the place. This brought to a pilot study which will be here referred to as Study 5 – “Aesthetic Experience and Descriptive Information in the Art of Re-purposing” (Chapter IX).

The aim of Study 5 was to investigate the role of linguistic descriptions in the aesthetic judgment of art, particularly for works of art related to sustainability (i.e., environmental art). Specifically, we compared some of the same environmental artworks used in Study 3 - “Aesthetic Experience and Environmental Art” (Chapter VII) with other kind of artistical

creations made reusing waste materials in a different fashion, so to check for any difference in the cognitive and affective responses related to this two distinctive ways of repurposing waste through art, as well as differences in the influence on pro-environmental intentions and their correlation with participant's individual traits.

Kilowatt is a company involved in various projects related to art and sustainability, being the venue for exhibitions, festivals, presentations, and art residences. At the same, in line with the conclusions reported in Study 3 (see §7.8) we intended to explore the effects that additional information could have on environmental intentions, using environmental art stimuli. Hence, this study could still represent an ulterior intersection of interests between my project's investigations and the company's needs. On one hand, the investigation was a coherent and consequential development of my research, given the findings obtained on Study 3. On the other hand, for Kilowatt it constituted a new opportunity to acquire useful information from which improve their artistic communication on sustainability in relation to their space and events. Furthermore, the experiment was conducted with spontaneously volunteering participants among the frequenters of the Greenhouses, a detail that increases the relevance of the research for both parties: for Kilowatt it represents an investigation based on their actual attendees, and for us, in turn, a scientific research with a great ecological value, given the opportunity to test our design with an heterogeneous type of sample, rather than just psychology university students (as for Study 3). Finally, then, this study constituted a way to bring this research out of academia, as well as for Kilowatt a further chance to put into practice the connection between science, art, and sustainability, tested in their own place with the people who frequent it.

The next two chapters (XIII and IX) will regard respectively Study 4 – “Aesthetic Experience and Space” and Study 5 – “Aesthetic Experience and Descriptive Information in the Art of Re-purposing”.

CHAPTER VIII

STUDY 4

Aesthetic Experience and Space

8.1. Introduction

Human orientation in new and familiar environments is a complex skill that can involve many different abilities and strategies (Burgess 2006; Wolbers & Hegarty 2010). Notably, the ability to orient and navigate relies on a variety of cognitive mechanisms (e.g., Burles, 2014; Hegarty et al., 2016), and it implies the processing of information from various sources which produce useful way-finding strategies during self-motion (Calton et al., 2008). There is evidence that spatial skills are malleable and could be improved by a training (Uttal et al., 2013) such as visual selective attention, spatial problem solving, and landmark recognition (Subrahmanyam & Greenfield, 1994; Feng et al., 2017; Cherney et al., 2008; Lövdén et al., 2012; Nemmi et al., 2017; Veurink & Sorby, 2019; Yamamoto et al., 2019). Hence, within these processes of navigation, visual information and landmarks play a major role (e.g., Ekstrom et al., 2014).

The term and concept of landmark was first introduced by Lynch (1960) in relation to things that contribute to the imageability of cities, and that he defined as features with distinctive spatial features which, by virtue of their colors, shape, or semantic values, have the potential to help people to orientate or to find their way in the environment (Lynch, 1960; Tlauka and Wilson, 1994; Appleyard, 1970). Indeed, Gestalt theory of visual perception considered landmarks as elements with defining characteristics that are different from their surroundings and easily recognized or discernible from a particular position (Schmidt & Delazari, 2013; Wagemans et al., 2012). Landmarks may be buildings that are different from their surroundings, as well as an element of a scene or curiosity object that can be singled out against a landscape background of repetitive detail (Oc & Tiesdell, 2007). Thus, landmarks structure environments, representing cognitive anchors, markers, or reference points for orientation, wayfinding, and communication (Richter & Winter, 2014). However, to date, the neural mechanisms responsible for the complex behavioral phenomenon of orientation remain

unclear due to the complexity of this cognitive process and the variability between individuals (Iaria et al. 2008; Liu et al. 2011). An influential model that has been developed to classify the different types of orientation skills is the landmark-route-survey (LRS) model, which is based on the sequence in which environmental information is encoded during exploration (Siegel & White 1975; Thorndyke & Hayes-Roth 1982).

The present study used behavioral tests, namely, a spatial configuration task and a cognitive map task, which assess two skills related to the LRS model in order to investigate people's cognitive ability in relation to a given spatial communication of a place, namely, orientation and creation of a cognitive map. Both spatial orienting skills have been tested using tasks implemented in virtual environments, which have been proved to be a valid way of training by several studies (McLaren-Gradinaru et al., 2020; Burles & Iaria, 2020; Umiltà, 2021; Parmar et al., 2022). The Spatial Configuration Task (SCT) is designed to assess the ability to generate and use configurable knowledge (i.e., a mental representation of the relationship between objects in an environment, or a “cognitive map”) of geometric objects in an environment (Burles et al., 2017). Specifically, it requires to integrate multiple viewpoints into a coherent mental representation of the environment and, subsequently, use that mental representation to infer one's own location based on limited visual information, a cognitive process that is known to support effective spatial orientation and navigation in humans (Wolbers & Hegarty, 2010). The cognitive map task (CMT) is a spatial orientation task that consists in the ability on cognitive-map-formation, and it is used to characterize an individual's capacity to orient and navigate in large-scale environments (Burles et al., 2014). This task was originally designed by Arnold and colleagues (2013) to assess participants' ability to form cognitive maps as tested in a virtual (video game-like) environment that resembles a city.

We adopted these two tasks for our study conducted in the outdoor space of the Greenhouses of the Giardini Margherita in Bologna, the headquarters of the Cooperative Society “Kilowatt”, partner company of my PhD project. Specifically, we tested participants on the tasks before and after moving around the outdoor space of the experimental venue, i.e., before and after a free tour and a guided navigation in which the experimenter conducted a place-finding task within the outdoor space. The guided navigation was meant to include those spots where the main landmarks of the environment were placed. After all the tasks, we asked participants about those landmarks in order to investigate their learning about the Greenhouse activities and behavioral guidelines for the place.

This investigation was implemented in regard to a renovation of the spatial communication that the company was making within their outdoor environments, concerning

mostly the substitution of signage-landmarks in ways that could improve people's knowledge and way of experiencing the place in a more sustainable fashion. The renovation thus aimed at providing more accessible information about the place identity and activities, as well as clear logistical direction on how to behave in respect to the sustainability of the space-environment. Therefore, our investigation concerned specifically: a) the usefulness and functionality of the various landmarks in correctly orienting people to move around the Greenhouses, examined through actual wayfinding tasks of the places (the guided place-finding task), and the two cognitive tasks implemented on a virtual environment (SCT and CMT); b) the information gained about the Greenhouses' identity and activities (qualitative data).

Originally, the study envisaged to compare the data collected from two different sets of signage-landmarks, namely, the one currently present before the renovation, and the new one that needed to be implemented. Hence, the study was supposed to include two different experimental phases, respectively, before and after the renovation, so as to compare the results obtained on the different tasks between the two phases (i.e., in relation to a different set of landmarks). The hypothesis was that the spatial renovation implemented would correspond to an improvement in certain orientation skills related to the recognition of the new landmarks, and consequent greater ease in being able to create a cognitive map of the place.

Unfortunately, due to a delay in the actualization of the work by Kilowatt, the renovation (i.e., the installation of the new landmarks) was not completed by the end of our contract of collaboration with the company. Therefore, the description that follows will regard exclusively the data and findings corresponding to the tests done in relation to the first set of landmarks. Although this temporal issue did not allow us to execute the comparison between the old and the new spatial communication, yet, the collected data could still provide important and useful insight about the relation between certain types of landmarks and the improvement of the orienting cognitive skills of the participants (measured before and after a free tour of the place), as well as important quantitative and descriptive information useful for Kilowatt in order to implement accordingly their new landmarks and spatial configuration of the outdoor space. Therefore, the analyses and results that will be discussed regard specifically:

1. The assessment of any improvement on the two virtual spatial tasks between the first and second session, and their correlation with the performance on the place-finding task, as well as with participants' sense of direction (quantitative analyses).

2. The report on the evaluation of the landmarks, which has been finally handed over to the partner company in order to accordingly implement their spatial renovation (descriptive analyses).

8.2. Methods

8.2.1. Participants

Twenty-two healthy participants were tested ($M_{\text{age}} = 32,22$, $SD = 3,43$; 50% females). They had normal or corrected-to-normal visual acuity and no self-reported history of attentional, psychiatric, or neurological disease. Informed consent for participation in the study and data treatment was obtained from all participants before the experiment.

8.2.2. Materials

8.2.2.1. Spatial Configuration Task (SCT) and Cognitive Map Task (CMT)

Participants' orienting skills were tested through two cognitive tasks implemented on virtual environments, the Spatial configuration task (SCT) and the Cognitive Map task (CMT).

The SCT consisted in a space-like environment containing five abstract objects set in a pentagon (Figure 2). Participants are not presented with the top-down view (Figure 2A), rather, they are situated at one of the objects, facing inwards toward the center of the pentagon in a first-person view. This limits the participant's view so that they can only see two of the five objects in the pentagon (Figure 2B). Thus, at each trial, the participant is shown a viewpoint from one of the objects in the environment, in which two other objects are visible. Participants are asked to identify which object the camera is situated upon (i.e. looking *from*), with all three non-visible objects provided as response options at the bottom of the screen (Figure 2B). After the participant responds, the camera translates and rotates to a new object and a new trial begins. To perform this task successfully, participants will need to combine a series of viewpoints into a coherent spatial representation of the environment, by processing the objects seen and movements performed by the camera. Initially, participants will be unfamiliar with the layout of the environment and are more likely to be guessing, but then they are expected to become more familiar over successive trials. The entire task consisted of 40 trials. Correctness (right or wrong) and response times (RTs) were measured.

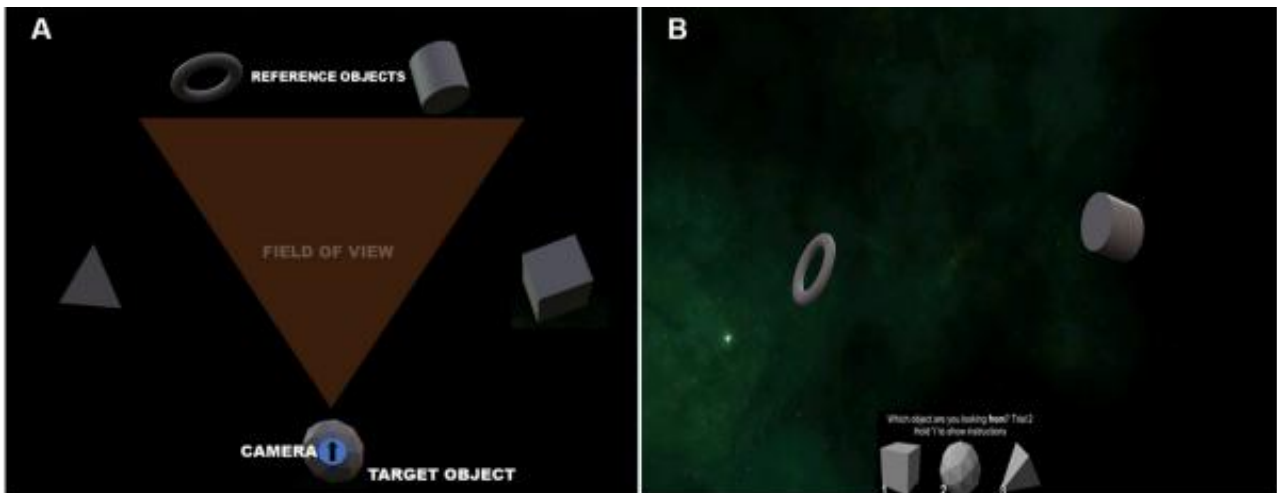


Figure 1. Figure 1A shows the top-down view of the pentagon (not presented to participants), and Figure 1B shows the participant's view when is asked to identify which object the camera is situated upon, with all three non-visible objects provided as response options at the bottom of the screen.

The CMT consisted of a series of trials in which participants watched a first-person perspective video of a person moving around the virtual environment (a virtual city, see Figure 2A) while encountering four target landmarks (i.e., buildings different from the others). The camera would stop in front of each landmark encountered so to emphasize its relevance. The duration of each video was one minute. Following the video, participants were presented with an aerial view of the same environment (Figure 2B) and were asked to place all four target landmarks in their correct location on the map. If the locations were correct, the task was completed. If the locations were incorrect, the participant saw another video. This task had 12 trials. We scored the number of trials that participants required to complete the task (i.e., the more trials the poorer the performance), and the total duration.

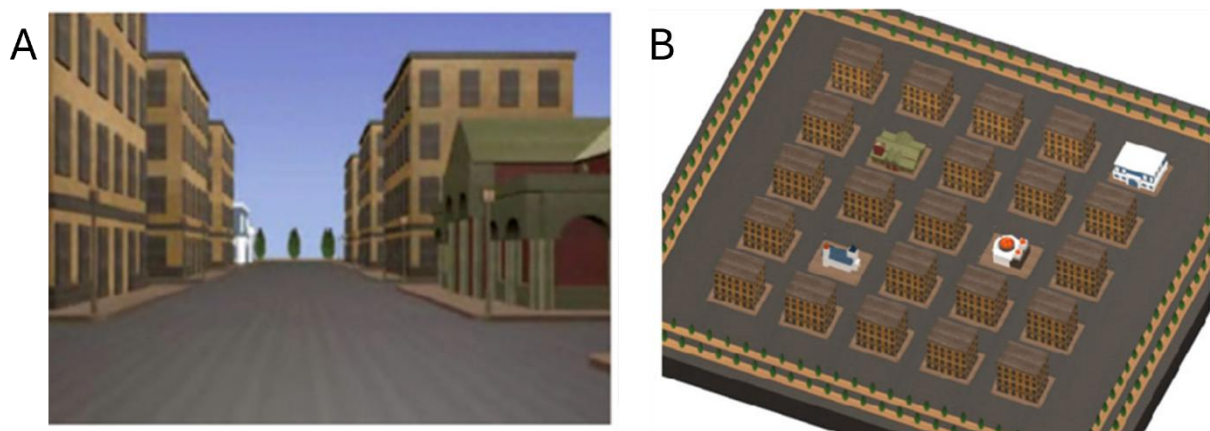


Figure 2. First-person perspective (2A) and aerial view (2B) of the virtual city used for the Cognitive Map task.

Participants completed the two virtual cognitive tasks twice, namely, before and after a free tour and a guided (with the experimenter) place-finding task around the outdoor space of the Greenhouse.

8.2.2.2. Free tour and guided Place-finding task

The free tour consisted of a 5-minutes free walk around the whole place. Participants were free to go anywhere within the borders of the Greenhouses' outdoor area.

In the place-finding task, the experimenter asked participants to show how to go to five specific points of the outdoor space of the Greenhouses. Participants needed to show the points by walking toward it, taking the shortest possible route to reach them. The starting point was the "Serra Sonora", an indoor and silent place adapted as a laboratory for testing the VR tasks, and the points to be reached were in order: fountain, vegetable garden, outdoor toilet, nearest recycling bin, outdoor bar (the different points of the area can be found in the map, see Figure 1 of Appendix C). Each point reached was the starting point to go to the next one. During the task, travel times (for each trajectory from point A to point B) and errors (misdirection) were measured.

8.2.2.3. Sense of direction

Finally, in order to check for any correlation between the responses in the various tasks and participants' sense of direction, we assessed the Santa Barbara Sense of Direction scale (SBSODS), consisting of 15 items (e.g., "I can usually remember a new route after doing it only once"). Answers were provided on a 7-point Likert scale ranging from 1 "strongly agree" to 7 "strongly disagree". The scale was adopted from Hegarty et al. (2002) and it measures participants' self-reported ability to orient and navigate in their spatial surroundings as experienced in their daily life. Scores on positively worded items were transformed such that higher scores are indicative of a greater perceived sense of direction.

8.2.2.4. Internal company survey

In respect to the renovation of the spatial communication and the implementation of the new set of landmarks, we investigated the Greenhouses' audience behavior and their use of the present landmarks collecting two different data sets.

First, informative data was collected from the company employees. The aim of this questionnaire was to find out from the company internal team what could be useful to improve with the renewal, based on the issues that they considered most urgent. Specifically, four open questions were administered:

1. “Which is the information you need to give to the public of Greenhouses the most often? (one or more indications, the ones that come to mind)”.
2. “What is the behavior that makes you angry off the most about the Greenhouse audience? (or things you don't want them to do)”.
3. “Can you tell us one thing you would like the Greenhouses audience to know or understand about the whole Kilowatt ecosystem? (more than one, if you have more)”.
4. “Is there any general suggestion you would like to give to those who will design the new signage-landmarks?”.

8.2.2.5. Landmarks evaluation questionnaire

The second data set regards the questionnaires that participants filled out about the evaluations of the landmarks.

We examined ten different landmarks among which there were four *directions panels* (Map, Office Totem, Recycling panel, Toilet panel) and six *informative panels* (Compostable materials panel, Greenhouse Info panel, Fountain panel, Garden panels, Aquaponics Aquarium panel, and Wall panel). Images of all the landmarks/panels are included in §1 of Appendix C. The questionnaire included both closed and open questions. For the *direction panels*, the closed questions regarded the noticing, use, utility, and functionality of the different landmarks for the orientation in the Greenhouses. Questions were adapted from Kato and Takeuchi (2003). The open questions, in turn, regarded the quantity and the place of the landmarks noticed. Specifically, the following parameters were measured:

- a) Having noticed or not the landmark (one item, “Did you notice this sign?”, response: “yes” or “no”).
- b) Use of the landmark for orientation (one item, “Did you use this sign to find your way around the Greenhouses?”, response from 1 to 5: 1 “not at all”, 5 “very much”).
- c) Utility of the landmark (one item, “How useful was this sign?”, response from 1 to 5: 1 “not at all”, 5 “very much”).
- d) Functionality of the landmarks (one item, “How much would you use this sign in the Greenhouses to give directions to someone else?” response from 1 to 5: 1 “not at all”, 5 “very much”).

- e) Quantity of the same landmark noticed (one item, “How many signs like this did you noticed?”¹⁵, open answer).
- f) Place (one item, “Could you tell where you have seen it/seen it?”, open answer).¹⁶

For the *informative panels*, the closed questions regarded the noticing, the functionality, and the attention paid on the landmark-sign. The open question regarded the place where it was seen. Specifically, the following parameters were measured:

- g) Having noticed or not the landmark (one item, “Did you notice this sign?”, response: “yes” or “no”).
- h) Functionality of the landmarks (one item, “How much would you use this sign in the Greenhouses to give information to someone else?”, response from 1 to 5: 1 “not at all”, 5 “very much”).
- i) Attention to the content, (one item, “Did you read its contents during the tour of the Greenhouses?”, response from 1 to 5: 1 “not at all”, 5 “very much”).
- j) Place (one item, “Could you tell where you have seen it/seen it?”, open answer).¹⁷

In addition, the questionnaire included also the following open questions:

- k) “Which information did you learn about the Greenhouses and its activities? Please, write down what you remember”.
- l) “Do you remember any information about the vegetable garden? If yes, please write it down”.
- m) “Do you remember any information about the garden? If yes, please write it down”.
- n) “Do you remember any information about the fountain? If yes, please write it down”.
- o) “Do you remember any information about recycling? If yes, please write it down”.

¹⁵ Only for these three panels: map, toilet, recycling

¹⁶ Functionality, Quantity, and Place (items “d”, “e”, and “f”) were asked only if the answer to item “a” was “yes”.

¹⁷ Functionality and Place (items “i” and “j”) were asked only if the answer to item “a” was “yes”.

8.2.2.6. *Familiarity with the place*

Familiarity with the place (Prestopnik-Ewoldsen, 2000) was assessed with two items: “Have you ever been to the Greenhouses before?” (response “yes”¹⁸ or “no”) and “How familiar is this place to you?” (response from 1 “not at all” to 7 “very much”).

The complete list of items in Italian language is provided in §2 of Appendix C.

8.3. Procedure

The experiment took place at the Greenhouses of Giardini Margherita in Bologna. Once arrived at the venue, participants were welcomed in the “Serra Sonora”, a close and silent room adapted as a laboratory. There, participants primarily filled out the informed consent, and then they completed the SBSOD and the place familiarity questionnaires. Both questionnaires were administered online using Qualtrics platform (Qualtrics, Provo, UT).

Subsequently, participants performed for the first time both virtual spatial ability tasks (first the SCT and then the CMT, always in this order) on a computer. Both tasks had instructions in Italian. At the end of the second task, participants were asked to take an exploratory free tour of the Greenhouses. They were instructed to have five minutes to go around the outer space of the Greenhouses and to try to gather as much information as possible about the place. They were completely free to move anywhere inside the boundaries of the area (the boundaries for navigation were indicated by the experimenter). Each participant was given an alarm clock that sounded 30 seconds before the end of the five minutes free tour, as a signal that they should go back to the meeting point (the “Serra Sonora”).

After the free tour, they performed the place-finding task. During this task, they were silently followed by the experimenter who needed to guide them through all the trajectories, i.e., confirming they had reached the right place each time and then ask for the new route. During each route from point A to point B, the experimenter noted their direction errors and travel times. Participants were instructed that they could not ask for any information, but they could use the direction panels if they wanted to (e.g., the Map).

At the end of this session, participants had to complete again the two virtual spatial ability tasks. Finally, they filled out the questionnaire about the evaluation of the landmarks. The whole experiment could take a wide range of time depending on the participant’s

¹⁸ If the answer was “yes” the subsequent open question was asked: “How many times have you been to the Greenhouses?”.

performance in the place finding task and in the two sessions of the virtual spatial tasks (e.g., the CMT could last just few minutes or even 15 minutes depending on the correct execution of the task or not). Hence, the duration of the experiment ranged approximately between 30 and 60 minutes.

8.4. Analyses and Results

8.4.1 Spatial configuration task (SCT) and Cognitive Map Task (CMT)

In order to check participants' performance on the two virtual spatial tasks, t-tests were done between the first and second session.

For the SCT, analyses concerned the number of correct answers and response times (RTs). Results show that correct answers in the second session were significantly higher than in the first one ($t = -4.97, p < .001$), and the RTs were significantly shorter ($t = 3.29, p = 0.004$). For the CMT, analyses concerned the number of trials (i.e., attempts) spent in finding the right solution, and the whole duration of the task. Results show that the number of attempts in the second session was significantly lower than the first one ($t = 1.90, p = 0.036$), as well as the whole duration of the task ($t = 3.06, p = 0.003$). Therefore, for both tasks there was a significant improvement between the first and the second session.

8.4.1.1. Correlations with place-finding task and sense of direction

Then, we checked for any correlation of the results on the two virtual spatial tasks with the performance on the place-finding task, and with participants' sense of direction. For the SCT, a positive correlation was found between the improvement on the task (i.e., the subtraction between the percentage of correct answers in the second and the first session) and the average of correct direction choices¹⁹ in the place-finding task ($r = 0.406; p = 0.034$). Conversely, no correlation was found between the average time of the improvement in the task (i.e., the difference between the response times of the first and second session) and the performance on the place finding task.

For the CMT, no correlations with the correct direction choices of the place-finding task were found, neither for the improvement on the task solution nor for the total duration of the task. Finally, for neither of the two tasks a correlation with the SBSODS was found.

¹⁹ The score of correct direction choices for each participant was obtained subtracting the number of errors done, to the general total number of choices needed to complete the full task.

All in all, these findings show that there was a significant improvement between the first and second session in both the spatial tasks. In addition, the correlation between the SCT and the performance in the place-finding task suggests that the ability measured by the former might have gained temporary reinforcement due to the physical orientation trained by the latter within the outer space of the Greenhouses. Though, it is not possible to assume whether this may be caused by the specific landmarks set since we do not have a comparison with another condition (i.e., with different landmarks or without any).

8.4.2. Descriptive analyses

8.4.2.1. Internal company survey

Responses of the internal company survey administrated Kilowatt's working team concerned what they would want from their visitors. We have clustered and summarized their answers in three main points/issues:

1. Knowing how to well orient themselves within the space of the Greenhouses (e.g., where all the main spots are and what is allowed to do).
2. Understanding and getting to know the place better: who runs it (what Kilowatt is and what it does), how it is managed, which are the events, and the info about the greenhouses.
3. Taking care of the place: respect for rules and spaces (e.g., cleanness and sustainability).

Furthermore, in regard to their suggestions for the renewal, we collected the following answers (inside brackets is the number of people who suggested it): (5) inclusiveness for language, gender, disability; (5) simplicity and clarity (little info but clear); (2) more accessible to reading; (2) more inviting (intriguing); (1) more entertaining; (1) made with sustainable materials; (1) give new names to spaces; (1) high signage (no low signage such as lines on the ground); (1) use of universal colors and signs; (1) communicating historical references on site; (1) totems made of plants; (1) to be placed on all entrances.

8.4.2.2. Familiarity with the place

Regarding the familiarity with the place, 63.7% of the participants had been there at least once, but the overall familiarity was low ($M = 2.9$ out of 7, $SD = 1.87$).

8.4.2.3. Evaluation of the landmarks

In respect to the landmarks' evaluation, the most noted were the Recycling panels (77.27% of positive answers), whereas the least noticed were the Compostable materials panel and the Greenhouse info panel (68.18% negative answers), followed by the Aquaponics Aquarium panel (59.09%) and the Garden panels (54.54%). These data show that on average participants did not notice important landmarks related to the sustainability of the place, and they could be interpreted as in line with the issues that emerged from the internal company survey, such as the lack of knowledge about the activities (e.g., the Greenhouse and the Aquaponics Aquarium) and the errors usually made in recycling materials. Furthermore, in relation to the attention to the content of the informative panels (for those who read it), the average for all six landmarks was below 3 out of 7, except for the Compostable material panel which medium was 3.4 (SD = 1), though only 7 participants out of 22 noticed it. Similarly, the use of the directional panels was always below 3 out of 7, except for the Toilet panel (M = 3.72; SD = 1.009). The utility of the directional panels was not high either. Only the Recycling panel (M = 3.64; SD = 1.41;) and the Toilet panel (M = 4.18; SD = 1.07) were above the medium score. Functionality for all the panels was also averagely low: the Fountain panel had the highest scores (M = 3.7; SD = 1.15) whereas the Wall panel received the lowest (M = 1.18; SD = 1.13).

All in all, these data show that the signage-landmarks were hardly noticed, except for the Recycling panel which is frequently noticed and in various spots of the place. When noted, the directional panels (needed for orientation within the outdoor space of the Greenhouses) are averagely used, useful and functional. The informative panels, in turn, are read on average.

Finally, in regard to the open questions of the questionnaire, there are three things that participants reported the most: the presence of the vegetable garden (47% of the participants), presence of a bar/restaurant (52%), and the coworking space (38%). The presence of cultural events and free drinkable water (the fountain) was reported only by 22% of the participants, and only the 4% the aquaponics aquarium. In terms of specific information acknowledged through the informative panels, no one reported info on compostable materials and the vegetable garden. Only 20% reported the availability of public drinkable water, and just one person reported that the types of plants are written on the Garden panels. Finally, participants gave different and general descriptions about the entity and purpose of the Greenhouses, here some examples: "presence of urban gardens", "sustainable agriculture", "focus on organic",

“following an ecological line”, “space given back to the city”, “free space”. All in all, these comments and data show that the work of Kilowatt within that place is not well understood.

8.5. Discussion

The original aim of this research was to compare the orientation and navigation within the outdoor space of the Greenhouses of Giardini Margherita (headquarters of the partner company of my project, Kilowatt) before and after the renovation of the spatial communication that the company was supposed to implement by changing the main landmarks in order to improve frequenter' behavior in relation to the sustainability of the place. Kilowatt's activities are strictly related to sustainability, including aspects such as recycling, use of compostable material, greenhouses, aquaponics aquarium, vegetable and flowers garden maintenance. Unfortunately, the company did not complete in time their works for the renovation and thus the comparison between the two sets of landmarks was never actualized. Nevertheless, the data collected still provides interesting insights into my research, as well as very useful information for the partner company. Indeed, we could test in a very ecological way the actual behavior of people within a green environment that is intimately related to the realm of sustainability. For Kilowatt, in turn, our results represent an important tool in order to adjust their renovation and adapt their space accordingly.

On one side, our quantitative analyses show that, although the effort that the company makes in encouraging sustainable behavior inside its space, participants did not acknowledge it that easily. The stress on recycling activity seems to be working well and efficiently catches people's attention, though, the recycling panels seem to be the only ones so efficient, whereas the other important sustainable activities of the company are somewhat neglected. This means that efficient communication through landmarks and signage is as important for sustainability as it is the existence itself of the activities and the places (Popescu, 2015; Brkovic & Stretovic Brkovic, 2017; Quan et al., 2024), and the mere presence of the green surrounding areas is not enough to induce people to act sustainably (Wolch et al., 2014).

Indeed, from the comparison between the internal survey's responses and the evaluation of the landmarks by the study participants, it is possible to assume that people who frequent the Greenhouses (almost 70% of the participants had been there at least once) may generally know just little or nothing about the place, its history, how it is run, what events there are, what the various spaces are dedicated to, and what rules and services are available. The existing spatial communication does not seem to be adequate to counter this problem: it is hardly

noticed, and from the reported comments it seems that people cannot get a clear idea of the place through the information they find. As a result, their conception of what the Greenhouses are and their value remains vague (e.g. a pleasurable place where there is some regard for sustainability).

Landmarks and signage related to the sustainability of the place are not much noticed, and thus not useful and functional as they should be, suggesting that a replacement for most of them is probably needed. The recycling panels are generally the most positively evaluated, as well as the description of the fountain for the public drinkable water, but their overall attractiveness is not very strong, and the aesthetic attractiveness may be crucial to catch attention and anticipate interaction and sustainable behavior in terms of object affordances and actions, as it has been largely discussed throughout the present thesis. Here, rather than just objects, the perception and evaluation of the landmarks concerned the overall sustainability of spaces and the consequential behavior within it.

In conclusion, although it is not easy to predict how people would act if guided by a different spatial communication, our findings can still provide some suggestions for the implementation of the new landmarks. First, they should probably be larger, clearer, and simpler than the existing ones (less descriptions but bigger and more direct). Second, they need to be numerically more than those currently present, as well as with more informative contents (they barely contain information that explain clearly Kilowatt's history and management, or the use and utility of the greenhouses and the vegetable garden), since signage is often missing or either not very informative or badly arranged. Finally, Kilowatt has room for improvement in the promotion of its various events and activities which often bring together art and science in relation to sustainability, thus valorizing the wonderful venue of the Greenhouses in Giardini Margherita and the very important and crucial work that his team does for that place and in general for the territory.

CHAPTER IX

STUDY 5

Aesthetic Experience and Descriptive Information in the Art of Re-purposing

9.1. Introduction

Art can have the ability to evoke emotions and offer the viewer a space for reflection that differentiates it from most forms of scientific communication on environmental issues (Klöckner, 2015). There are, in fact, several advantages for visual arts in this area, as they can help shape behaviors by influencing values, beliefs, and attitudes (Reid et al., 2005), functioning as a powerful tool to induce emotional engagement and encourage sustainable actions (Roosen et al., 2017). Moreover, literature on aesthetic experience with art shows that viewers can receive important benefits from reading descriptive information about the artworks and/or the artist (Castellotti et al., 2023; Gerger & Leder, 2015). Specifically, curatorial information can increase the understanding and appreciation of artworks, provoking a more positive and intense aesthetic emotion (Szubielska et al., 2019; Darda & Chatterjee, 2023; Mastandrea & Umiltà, 2016; Szubielska & Imbir, 2021; Swami, 2013).

In the present study, differently from Study 3 – “Aesthetic Experience and Environmental Art” (Chapter VII) in which no descriptive information of any sort was given about the artworks and artists, we introduced this component and aimed to investigate its effects in relation to cognitive and affective factors, as well as for pro-environmental intentions. Specifically, we tested some of the same stimuli used in Study 3 as well as other new stimuli, either with or without the addition of descriptive information about the artists and the creation of their artworks. The new stimuli were chosen among the works of two contemporary artists who make their creations as well from the reuse of waste materials, though, with a different style than the ones already used in Study 3. Hence, the two sets of artworks represent two different kinds of repurposing waste material through art.

The aim of the study concerns the role that the descriptions about these artists and their artworks can play on their aesthetic judgement, and consequently on the affective and cognitive

mechanisms that can influence pro-environmental intentions of the participants/viewers. In line with the conclusions reported in Study 3 (in which the evaluation of beauty and the overall emotional engagement was not high, see §7.7.2), in order to produce an effect on intentions here we intended to enhance the affective influence of the stimuli, as well as the overall emotional engagement. Hence, we expected the descriptions to impact on the affective and emotional response to the experience, which in turn should also increase the creation of a personal meaning for the viewer, bringing him/her closer to the topic and more willing to act. Specifically, then, we expected people to judge the artworks as more beautiful and meaningful after reading information about their creation and the artist's history, as well as having a stronger emotional and cognitive reflecting response. Furthermore, since these artworks aim to raise the viewer's awareness of environmental problems, the assumption is that those who receive the information will also be more intent on doing something for the environment than those who experience the artworks without any additional description. Lastly, we should expect this effect to be modulated by participants' individual traits in regard to environmental protection. Therefore, the following hypothesis were brought forward²⁰:

H1. Evaluations of beauty and meaningfulness of the same artworks should be higher when participants are provided with the general description of the artist's work than when they are not.

H2. Intentions for pro-environmental behavior should be greater for those participants who experienced the artworks with the general descriptions of the artist's work.

H3. Evaluations of beauty and meaningfulness, as well as the intentions for pro-environmental behavior, should be positively correlated with the individual traits in respect to participants' ecological worldview, i.e., the greater the ecological view, the higher the affective and cognitive impact should be (evaluations on beauty and meaningfulness), as well as the willingness to act in favor of the environment (intentions for pro-environmental behavior).

Nevertheless, given that it consists of a pilot study, the results in respect to H1 and H2 cannot be quantitatively analyzed, thus, only descriptive statistics will be given. For H3, in turn, preliminary quantitative analyses (i.e., correlations) are reported.

²⁰ Note that the above hypothesis regards strictly the comparison between the two conditions showing the same set of artworks (i.e., either the old set of stimuli already used in Study 3, or the new set) with or without descriptive information. We do not have any specific hypothesis on whether one style should be more effective than the other, hence, we consider any results in this regard to be merely exploratory.

9.2. Methods

9.2.1. Participants

Twenty-four healthy participants were tested ($M_{\text{age}} = 29,12$, $SD = 7,69$; 50% females). They had normal or corrected-to-normal visual acuity and no self-reported history of attentional, psychiatric, or neurological disease. Participants were selected by inviting the people present in the Greenhouses to join the study on a voluntary basis. Informed consent for participation in the study and data treatment was obtained from all participants before the experiment.

Approval was obtained from the ethics committee of the Department of Philosophy and Communication of the University of Bologna. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

9.2.2. Materials

9.2.2.1. Stimuli

Participants were divided into four different groups (i.e., four conditions *between* participants). Group 1 and 2 were exposed to artworks selected among those already used in Study 3, namely, images of creations by Alejandro Duran and Benjamin von Wong (see §7.2.3. in Chapter VII for more information about their work). Specifically, images of eight artworks from each of the two artists were used, for a total of 16 stimuli per group/condition. For Group 1 only, the images were preceded by a description of the artist and his work, whereas Group 2 received no additional information. The two groups will be hereafter referred respectively as DWd and DWnd. The additional information given to DWd consisted in two descriptive texts, one for each artist.

Group 3 and 4 were exposed to images of artworks created by Jane Perkins²¹ and Annarita Serra²². Both artists make their artworks reusing small scrap materials and litter. Although with a slightly different style, they both share a similar technique in making their creations, as well as in respect to sustainability (i.e., the reuse of waste materials). Therefore, as for the other two artists, we put together their works within the same set (i.e., groups/conditions). The addition of these two artists' work in this study was thought to explore the effect of a further way of creating environmental artworks. Rather than massive outdoor

²¹<https://janeperkins.co.uk/plastic>

²² <https://annaritaserra.com/>

installations such as Duran and Von Wong's artworks, their creations are paintings-dimension type of artworks, made with very small parts of different waste materials, sometimes called indeed as waste art or trash art (Naglieri, 2010). Specifically, the stimuli that we selected from Jane Perkins are reproductions of famous art masterpieces (e.g., Klimt's *Kiss* and Leonardo's *Mona Lisa*), whereas those by Annarita Serra are improvised composition that the artist made with the litter found along the cost of Sardinia, where she is based (see Figure 1 for an example). Their work has indeed an ecological value related to consuming and repurposing of waste materials in an artistically beautiful way (all artworks/stimuli as well as the descriptions used about the artists and their work are included in §1 and §2 of Appendix D). For Group 3 only, the images were preceded by a description of the artists and their work, whereas Group 4 received no additional information. The two groups will be hereafter referred respectively as PSd and PSnd. As for DWd, the additional information given to PSd consisted in two descriptive texts, one for each artist.

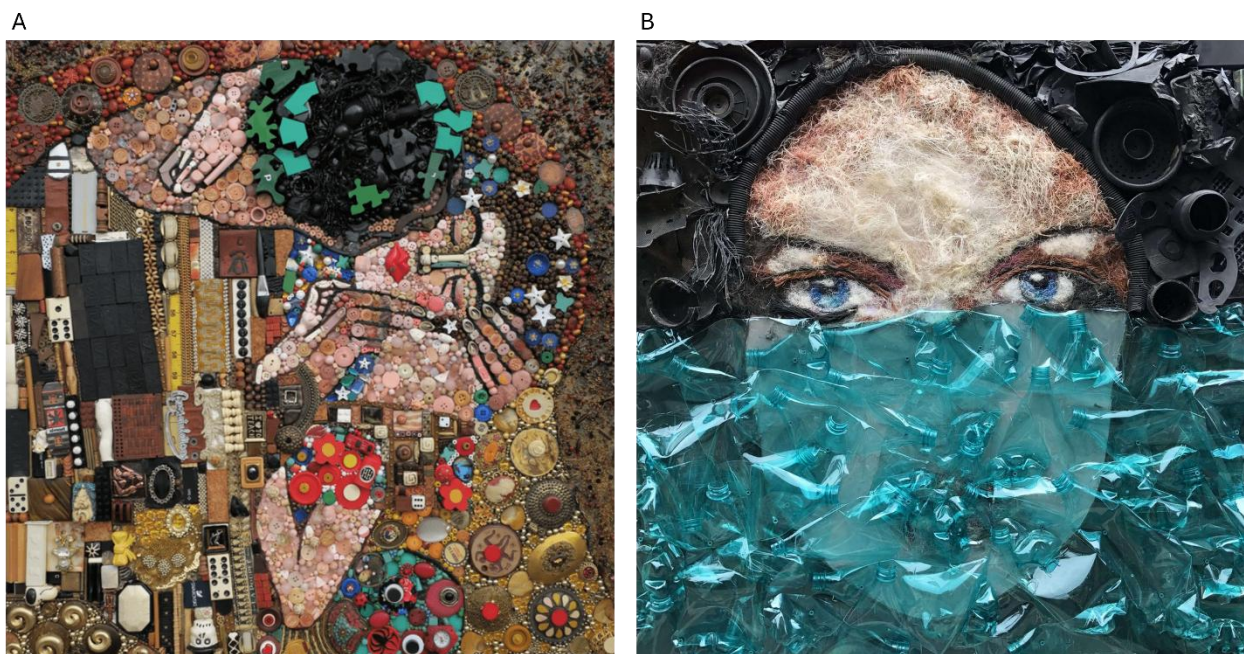


Figure 1. Two of the artworks used for Group 3 and 4 (PSd and PSnd). Figure 2A is *The Kiss*, after Klimt (80cm x 80cm, 2019) made by Jane Perkins. Figure 2B *Message in a bottle* (Plastica dal mare, 90×90 cm, 2018-19) made by Annarita Serra.

Descriptions regarding the four artists were of the same length at pairs (158 words for Perkins and Von Wong, 153 words for Serra and Duran), and they included historical and biographical information about them and their work, provided within a neutral frame, i.e., without any kind of judgements or evaluations that could bias participants experience by

positive or negative framing. Indeed, the descriptions were formulated adapting the information present in the respective artists' websites, excluding qualitative adjectives or personal comments in regard to them or their artworks.

9.2.2.2. Variables

As for our previous study (Study 3, §7.2.4.3), participants' affective response was assessed by beauty and emotional reactions to the experience, whereas cognitive responses regarded meaningfulness and cognitive reflection. Beauty and meaningfulness evaluations were registered also for each stimulus/image. In addition to these variables, for each artwork it was asked to give a monetary estimation. Intentions to change behavior (ICB) and intentions for pro-environmental behavior (IPEB) were assessed after the exposure to the stimuli with two separate sets of questions.

Participants' individual traits in respect to ecological worldview and environmental protection were assessed by two measures: the New Ecological Paradigm (NEP) scale, and Perceived Behavioral Control (PCB). It follows a detailed description of the variables. The complete list of its items used in Italian language are reported in §3 of Appendix D.

9.2.2.2.1. Beauty. Evaluation of Beauty for each image was assessed by one item ("How beautiful do you think the image is?"), as well as for the evaluation of the whole experience ("To what extent do you think the images were beautiful?"). In both cases participants could response on a continuous scale ranging from 0 ("not at all") to 100 ("extremely").

9.2.2.2.2. Emotions. Emotional reactions were assessed after the whole exposure session with the question "To what extent did this experience bring up each of these feelings with you?", adapted from Sommer and Klochner (2019). As for Study 3, fourteen different emotions were assessed, including seven positive (happiness, hope, awe, surprise, inspiration, relaxation, enthusiasm) and seven negatives (guilt, sadness, disappointment, helplessness, anger, anxiety, shame). Responses ranged on a scale from 0 ("not at all") to 100 ("extremely"). Two composite items were created to represent a broad measure of positive emotions and negative emotions. Both were obtained by averaging the scores to the seven positive or seven negative emotions.

9.2.2.2.3. Meaningfulness. As for Study 3, Meaningfulness for each image was assessed through three items, shown always in the same order: the first question denoted the understanding of the images' content ("How well did you understand the content of this image?"), while the other two regarded respectively their relevance for the self and for society

(“How relevant is this image to you personally?”; “How relevant do you think this image is to society?”). An average of the three items was performed to have a general measure of the variable. As for Beauty, after the exposure session we assessed also Meaningfulness of the whole experience with one item (“To what extent was the experience of this experiment meaningful for you?”) adapted from Trupp et al. (2023). In all cases, participants response could range from 0 (“not at all”) to 100 (“extremely”).

9.2.2.2.4. Cognitive reflection. Cognitive reflection was assessed after the exposure session through four items (e.g., “This experience makes me think about my own role in the community”), adapted from the “reflecting on the artwork” questions used in Klockner & Sommer (2021). Responses ranged from 0 (“strongly disagree”) to 100 (“strongly agree”). An average of the four items was performed to have a general measure of the variable.

9.2.2.2.5. Monetary estimation. We assessed the monetary estimation that participants would give for each artwork. This choice was meant to investigate the perceived value that participants had of the artworks in monetary terms, so as to check for possible correlations between this evaluation and the scores obtained in the affecting and cognitive measures. It consisted in one item (“What monetary value would you attribute to this artwork?”), and responses could range on a continuous scale from 0€ to 1000€.

9.2.2.2.6. Intentions to change behavior (ICB). As for Study 3, intentions to change behavior were assessed by six items related to consuming (e.g., “In future, I will try more often to repair damaged objects.”), adapted from Gansser & Reich (2023). Participants' answers to the six items were averaged to obtain the main variable. Responses ranged from 0 (“strongly disagree”) to 100 (“strongly agree”).

9.2.2.2.7. Intentions for pro-environmental behavior (IPEB). IPEB was assessed through eight items (e.g., “To what extent are you willing to adopt the following behaviors in the coming months: recycle materials”), adopted from Di Santo et al. (2024) (originally from Wu et al., 2021). Responses ranged from 0 (“not at all likely”) to 100 (“very likely”). Among the variables used in this study as DV (i.e., dependent variable), this is the only one different from Study 3.

9.2.2.2.8. Ecological worldview. Beliefs and concerns associated with the endorsement of an ecological worldview in favor of the environment, were assessed by the New Ecological Paradigm (NEP) scale adopted from Dunlap et al. (2000), and including 15 items (e.g., “Humans greatly abuse the environment”). Answers to the odd-numbered items were reverse scored. A mean of the 15 items was computed to give a general score for the NEP. Responses

could range from 0 (“strongly disagree”) to 100 (“strongly agree”). Italian version of the scale already used and validated in literature (Prati & Zani, 2013; Pierantoni, Prati & Zani, 2011; Innocenti et al., 2022).

9.2.2.2.9. Perceived behavioral control (PCB). As for Study 3, PBC was evaluated with two scales. The first one consisted of five items from Gassner & Reich (2023) and regarding the difficulty in adopting that specific behavior (e.g., “For me, behaving sustainably is in general: completely impossible - very possible”). The second one consisted of one item (“For me, recycling facilities are: easily available – not easily”) about the availability to reach recycling facilities (Knussen et al., 2004). Items were averaged to compute a general score for PBC.

9.3. Procedure

The experiment was conducted inside the “Serra Sonora”, an indoor and silent room in the Greenhouses of Giardini Margherita which was adapted as a laboratory for the occasion. After signing the informed consent and data treatment, participants were administered with a first online questionnaire including the individual trait measures (i.e., NEP and PBC) and demographics information (age and sex).

Subsequently, participants were assigned to one of the four conditions. For any of the four groups, participants were shown with 16 different images representing pictures of the artworks/stimuli. Each stimulus was presented on the screen for 15 minutes (about the reasons for this choice please refer to the Procedure of Study 3, §7.4 of Chapter VII). After each image, participants needed to answer five questions concerning Beauty, Meaningfulness, and Monetary estimation variables. After the exposure session, they were directed to a further online questionnaire including all the other variables described above (i.e., beauty and meaningfulness for the whole experience, emotions, cognitive reflection, ICB, IPEB).

Both questionnaires were administered online through Qualtrics platform (Qualtrics, Provo, UT). The exposure to the artistic stimuli and the respective affective and cognitive responses were performed and collected using PsychoPy, version 2023.1.3 (Peirce et al., 2019). The stimuli were presented on a 14” monitor from a viewing distance of 57 cm. The entire duration of the experiment was around 30 minutes.

9.4. Analyses and results

As anticipated in the introduction, the present is a pilot study. Thus, the following section will report just the descriptives of the data collection in relation to H1 and H2, together with the analysis of the correlation between the variables in relation to H3. Indeed, the number of participants for each group/condition does not allow us to perform t-tests in order to check for significant differences among the Groups according to the study hypothesis. However, the trends observed in the descriptives and in the preliminary analyses will be discussed.

9.4.1. Descriptive statistics

9.4.1.1. *Single images responses*

In regard to the affective and cognitive responses related to the evaluation of the single images/artworks, the descriptive statistics show the same trend for both variables measured between Group 1 and 2 (i.e., participants exposed to Duran and Von Wong's artworks, respectively with or without description), since the average scores of the group that received descriptive information (DWd) are always higher than the respective group who did not receive any descriptive information (DWnd) for either both Beauty (DWd: $M = 63.9$, $SD = 9.68$; DWnd: $M = 51.9$, $SD = 25.1$), and Meaningfulness (DWd: $M = 75.2$, $SD = 14$; DWnd: $M = 65$, $SD = 22.6$). Between Group 3 and 4, instead, we observe the exact opposite trend: the average scores of the group that received descriptive information about the artists (PSd) are lower than the other group (PSnd), both for Beauty (PSd: $M = 54.5$, $SD = 13.4$; PSnd: $M = 63.2$, $SD = 11.4$) and Meaningfulness (PSd: $M = 55.6$, $SD = 9.30$; PSnd: $M = 63.2$, $SD = 12.8$). Interestingly, this trend is shown also for the Monetary Estimation variable (DWd: $M = 507$, $SD = 262$; DWnd: $M = 330$, $SD = 352$; PSd: $M = 330$, $SD = 117$; PSnd: $M = 494$, $SD = 233$).

9.4.1.2. *Post-exposure responses*

For the affective and cognitive responses related to the whole experience, i.e., the post-exposure variables, we notice the same trend just described but with some interesting differences.

Cognitive Reflection, for instance, follows the same trend, being higher for DWd ($M = 73.8$, $SD = 19.5$) than for DWnd ($M = 63.3$, $SD = 22.1$), and lower for PSd ($M = 56.2$, $SD = 18.6$) than PSnd ($M = 63.5$, $SD = 32.1$). Beauty of the whole experience obtained higher scores by both groups who received the descriptive information within both comparison (Beauty, DWd: $M = 68.3$, $SD = 13$; DWnd: $M = 54$, $SD = 24.5$; PSd: $M = 66.8$, $SD = 20.4$; PSnd: $M = 60.2$, $SD = 26.1$), whereas for Meaningfulness we observe an opposite trend than for Cognitive

Reflection, since scores are lower for DWd ($M = 62.8$, $SD = 7.88$) than for DWnd: $M = 66.2$, $SD = 25.5$), and higher for PSd ($M = 59.3$, $SD = 8.87$) than for PSnd ($M = 52.5$, $SD = 35.2$). Interestingly then, Beauty and Meaningfulness for the whole experience do not coincide with the evaluations on the single image, rather, they show opposite trends. Moreover, these are the only variables for which PSd (with descriptive information) received higher scores than PSnd (no descriptive information).

In regard to the emotional response, the scores obtained on the average between all negative emotions show the same trend seen for Cognitive Reflecting, namely, higher scores (even if just slightly in this case) for DWd ($M = 59.9$, $SD = 28$) than for DWnd ($M = 56$, $SD = 27.9$), and lower scores for PSd ($M = 32.5$, $SD = 23.4$) than PSnd ($M = 40.3$, $SD = 30.2$). For the average between all positive emotions, we observe the same trend between PSd ($M = 27.9$, $SD = 18.7$) and PSnd ($M = 43$, $SD = 27$), whereas DWd obtained lower scores ($M = 19.4$, $SD = 13.2$) than DWnd ($M = 24.4$, $SD = 10.9$). This is the only case in which DWd received lower scores than DWnd, though, this result is in opposition only on the surface: indeed, DWd and DWnd stimuli are the artworks by Duran and Von Wong which, as we have seen in Study 3, depict the plastic waste problem in a negative framing, hence, the addition of descriptive information further lowered the positive emotions for the group that received it (i.e., for DWd). Furthermore, these results show that the artworks by Perkins and Serra (PSd and PSnd) have a more positive frame, especially when seen without descriptive information (PSnd). Though, while there is a big difference between negative and positive emotions for DWd and DWnd (coherently with Study 3), it is not as such for PSd and PSnd.

Regarding intentions in favor of the environment, both variables follow the main trend that we have described so far, namely, higher scores for the group who received the descriptive information in the plastic waste artworks (DWd), whereas the opposite trend for the scrap materials artworks, (i.e., higher scores for PSnd). Indeed, IPEB received higher scores by DWd group ($M = 75.8$, $SD = 16.3$) than by DWnd ($M = 70.6$, $SD = 17.7$), whilst PSd obtained lower scores ($M = 67$, $SD = 16.4$) than PSnd ($M = 72.9$, $SD = 18.2$). Likewise, for ICB, although just slightly, DWd obtained higher scores ($M = 71.8$, $SD = 10.3$) than DWnd ($M = 69.8$, $SD = 20.3$), and PSd ($M = 60.2$, $SD = 18.5$) lower than PSnd ($M = 70.1$, $SD = 19$), with a greater difference within this last comparison.

Finally, regarding the individual traits in respect to environmental protection, all groups seem to be very similar. Indeed, scores obtained in the NEP are very similar among all four groups (DWd: $M = 68.3$, $SD = 4.78$; DWnd: $M = 67.5$, $SD = 7.53$; PSd: $M = 66$, $SD = 11.4$; PSnd: $M = 64.8$, $SD = 12.5$). Average scores obtained for the PBC are very similar as well,

although DWnd has a lower mean score in respect to the others (DWd: $M = 68.9$, $SD = 15.3$; DWnd: $M = 55.9$, $SD = 10.3$; PSd: $M = 65.9$, $SD = 16.3$; PSnd: $M = 64.1$, $SD = 19.3$). In general, these data show that the sample was quite homogeneous in terms of ecological worldview, hence, we can suppose that there would be no significant individual differences in relation to these factors (thus allowing for comparison between the different groups).

9.4.2. Correlations

Given that these analyses should be taken as mere preliminary and partial indications, we checked for correlations between the different variables in relation to H3. The following correlations regard the data collected from all 24 participants. Hence, since we merged the four conditions together for these analyses, we excluded those variables in which we found a large difference across conditions (i.e., emotions), and checked only those that had similar scores across conditions (based on the descriptive statistics).

Beauty has a positive correlation with Meaningfulness, for both the single images evaluations ($r = 0.669$; $p = <.001$) and for the whole experience ($r = 0.736$; $p = <.001$), as well as with the NEP ($r = 0.461$; $p = <.001$), and the IPEB ($r = 0.527$; $p = 0.008$).

Meaningfulness, in turn, is positively correlated with Cognitive Reflection either when evaluated for each single image ($r = 0.748$; $p = <.001$) than for the whole experience evaluation ($r = 0.592$; $p = 0.002$).

Monetary estimation is positively correlated with Beauty of the single images ($r = 0.669$; $p = <.001$) and for the whole experience evaluation ($r = 0.524$; $p = 0.009$), as well as with Meaningfulness ($r = 0.661$; $p = <.001$), Cognitive Reflection ($r = 0.748$; $p = <.001$), and ICB ($r = 0.484$; $p = 0.016$).

Cognitive Reflection, in addition to Meaningfulness and Monetary estimation, is positively correlated with Beauty of the whole experience ($r = 0.697$; $p = <.001$) and ICB ($r = 0.439$; $p = 0.032$).

IPEB, in addition to Beauty and Cognitive Reflection, is positively correlated also with the NEP ($r = 0.606$; $p = 0.002$) and PBC ($r = 0.618$; $p = 0.001$).

ICB, in addition to Monetary estimation and Cognitive Reflection, is also positively correlated with NEP ($r = 0.427$; $p = 0.037$).

9.5 Discussion

9.5.1. Descriptive results

The main investigation of this pilot study concerned the influence of descriptive information for the affective, cognitive, and intentions variables in response to some of the same stimuli used in Study 3 – “Aesthetic Experience and Environmental Art” and other types of environmental art stimuli regarding the reuse and repurposing of waste material, namely, reproduction of famous masterpieces and original artworks made of litter and small scrap materials.

In line with our predictions, results show indeed a constant difference between the groups that were exposed to the same type of stimuli with or without the addition of descriptive information. However, this addition does not seem to be modulated in the same way by the two sets of artworks. Responses to the plastic waste artworks made by Alejandro Duran and Benjamin Von Wong show effectively a constant increase for the group that received the descriptive information (DWd), in all the variables related to cognitive and affective factors (except, with reason, for positive emotions, since the artworks are negatively framed), as well as for intentions in favor of the environment. Conversely, the trend seems to be perfectly reversed of those groups that were exposed to the artworks of Jane Perkins and Annarita Serra, even if this accounts only for the results obtained on the single images evaluations, whereas for Beauty and Meaningfulness measured for the whole experience the group which received the descriptive information gave averagely higher scores. It would seem, then, that in this second set of artworks the descriptive information somewhat lowers the effect of the stimuli in the short term, making them less attractive, meaningful, and emotionally charged, but this is not confirmed in the overall judgement.

Furthermore, similarly to Study 3, Duran and Von Wong’s artworks received higher evaluations for Meaningfulness rather than for Beauty. This is replicated in the post exposure evaluations of the whole experience for the group that did not receive the descriptive information (DWnd). However, it is remarkable to observe that DWd (which received the additional information) gave higher scores on Beauty rather than on Meaningfulness. Perhaps, with these specific kinds of artworks (for which meaningfulness’ evaluations are already high without additional information), descriptive information affect more the judgements on beauty rather than those related to its meaningfulness, probably because this latter is already enough explicit even without descriptions. Conversely, the other set of artworks obtained very similar scores in these two variables. Interestingly, when presented without descriptive information

(PSnd), they received higher scores on Beauty than the respective group of the other set of artworks (DWnd).

The trend seen for the evaluations of single images is replicated as well for IPEB and ICB. Though, for these intentions' variables the gap between groups who received the descriptive information and those who received it seems (at least numerically) less pronounced than for the other variables. This could mean that, even if scores on Beauty are a little higher than the average registered in Study 3 for the same stimuli, the results obtained on intentions are more related to individual traits rather than to the affective responses, as we supposed already in the conclusions of the previous study. Indeed, average scores on the NEP are very similar among all groups, as well as for intentions. Instead, the large difference in the strength of the emotional reactions obtained among all groups suggests that there may be no such correlation between emotions and intentions.

Interestingly, this time the NEP scores are numerically two times higher than those of participants tested in Study 3. This data would represent an initial confirmation of our prediction that, inviting the frequenters of the Greenhouses as participants for the study, we would have disposed of a sample averagely well concerned about environmental sustainability (i.e., with a consistent level of ecological worldview).

All in all, these data suggest there is a constant difference between groups that received additional descriptive information about the artists and their works and those who did not receive it. Furthermore, this difference seems to take specific modulations in respect to the different kinds of artistic style, thus opening the way for further interesting investigations regarding this comparison. Indeed, the set of artworks that we presented have brought to different responses in terms of affective and cognitive factors: the negatively framed artworks by Duran and Von Wong being more cognitively engaging, whereas the little scrap materials compositions by Perkins and Serra enhanced positive emotions and beauty. Therefore, these findings could represent useful insights for the investigation about the effects that these types of art may have, respectively, in encouraging people's intentions in favor of the environment.

9.5.2. Correlations

In regard to the significant correlations obtained, although they must be considered only as partial results, there are a few overall observations that might deserve attention if we compare these trends with the findings obtained in Study 3.

First, in terms of correlations between cognitive and affective variables (though excluding emotions), this time Meaningfulness appears to be correlated not only with Cognitive

Reflection but also with Beauty. Most importantly, in this case we found also correlations between these variables and the intentions' variables, as well as with the individual traits. Indeed, Beauty is positively correlated either with the IPEB and the NEP. Cognitive Reflection, in turn, is correlated with IPEB and ICB. Furthermore, both IPEB and ICB are correlated with the NEP, and the former also with PCB. Brought together these preliminary findings may provide interesting insights into this overall research on environmental art and sustainable behavior, since they show that stronger affective (Beauty) and cognitive (Cognitive Reflection) responses may be indeed positively correlated with greater intentions in favor of the environment (IPEB and ICB), which in turn, are evidently correlated with the degree of concerns and ecological worldview (NEP) of a person.

Interestingly, it seems also that the higher the ecological worldview is, the higher will be the evaluation of beauty for any of these kinds of artworks, suggesting a connection between beliefs, concerns, and aesthetic preferences in relation to different styles of environmental art.

Finally, findings for Monetary estimation (a new variable which was not present in Study 3) suggest that the more we consider beautiful and cognitively engaging an artwork, the greater monetary value we would attribute to it. It is also worth mentioning its correlation with ICB, since most of the items included in this variable regarded the intentions to buy less in terms of consuming.

All in all, these preliminary findings would suggest that, given a strong ecological worldview about environmental issues (here two times higher than Study 3), individual traits as well as cognitive and affective factors are all proportionally positively correlated with the intentions to act for environmental protection. In other words, this data, if confirmed, would show that the more we are concerned about the environment, the more beautiful and meaningful we will judge this type of art (though with differences across styles), and the more we may also be inclined to act in favor of the environment, as shown in other studies (e.g., Zelenski et al., 2015). Nevertheless, the analyses conducted are limited and they can only suggest a possible correlation, but we cannot be sure of any causation, as well as we are not able to say whether the intentions have been influenced at all by the affective and cognitive mechanisms induced by the artworks, or if they are just related to participants' high degree of ecological view.

9.6 Conclusions for Part III

The work with Kilowatt has represented a great collaboration in which, in line with the objectives foreseen by the partnership, the research knowledge and the empirical methodologies of cognitive sciences were put into practice in a concrete and applicative manner within the space and activities of a company which dedicates much of his attention to sustainability. Thanks to this collaboration, it was therefore possible to accomplish the Third Mission envisaged for my PhD project, bringing the research outside of Academia and applying it within the local social context of our city, in collaboration with a company that for many years has been working in favor of the adoption of green and sustainable circular economy strategies, often connecting art and science. It was thus a worthwhile and fruitful combination, which took place in a suitable and appropriate context for the implementation of our research.

Specifically, Study 4 – “Aesthetic Experience and Space” may represent a very original way through which the empirical method can be applied to help third parties in improving the sustainability of their spaces. With Study 5 – “Aesthetic Experience and Descriptive Information in the Art of Re-purposing”, in turn, we tested my investigation about the effects of environmental art with the people who frequent the Greenhouses, thus bringing our empirical aesthetics research out of the laboratory, and in a sustainable environment. Findings obtained in these two studies can provide important information for future developments in both types of research, respectively, for universities’ Third Mission in relation to cognitive science’s empirical methods applied to sustainability, and for the investigation on the affective and cognitive responses related to the aesthetic experience of environmental art made from the reuse and re-purposing of waste, and its effects in encouraging pro-environmental intentions.

CONCLUSIONS

"I believe that art is the essence of life, as much as anything can be a true essence. It is extracted from existence by a process. Art is a reflection on life and an analysis of its structure. As such, art should be a great moving force shaping the future" (Agnes Denes).

Doing a PhD is not like a walk in the park. The road is challenging and fascinating at the same time, but most of the time it is hard to figure where exactly your route is going to take you. Projects may develop in several directions throughout the three years, sometimes also in ways that are hard to predict at the very beginning. This is quite common for a PhD career, sensations shared between most doctoral students from many fields. In my opinion, my project had two further difficulties than standard doctoral courses. First, it had to be interdisciplinary for its own nature. Given the intention to make cognitive science intersect with art and green sustainability, it was fundamentally inevitable to take into account different and sometimes even quite distant literatures. Dealing with distinctive scientific areas can be tricky in respect to an academic project, since each field has its own narratives, approaches, and methods. Second, my scholarship had the innovative but at the same time quite unusual and unique requirement to collaborate with a company. Given the already fluid nature of a doctoral career, it is probably not hard to figure out the venture that constructing such a collaboration means. To intersect companies and academic research may bring unexpected enlightening outcomes, yet, those two entities still often speak different languages, and my role was also to be an intermediary between these two worlds. In short, beyond and before all the things reported in this thesis, my PhD project was marked from the very beginning by these peculiar characteristics.

Our main goal was to investigate new strategies that could enrich the research for green sustainability in relation to objects' materials, waste management, artistic reusability and renovation, environmental awareness and sustainable behavior. Hence, a three-way encounter was planned between cognitive science, art, and sustainability. Specifically, I tried to merge experimental psychology with empirical aesthetics so as to derive from this encounter an original combination of knowledge and expertise that could give rise to new theoretical and experimental perspectives on environmental sustainability.

With the aim of coming up with new strategies for more sustainable behaviors, I started my investigation from the very base, from the roots of cognitive processes: perception. Throughout my first year I delved into the study of cognitive affordances in relation to everyday objects, as well as semiotics of perception, and up to the most contemporary theories belonging to the 4E cognition and predictive processing accounts. In looking for new insights into the modulation of our perception of everyday objects, we investigated the activation of affordances in regard to the change of material, an element not as much inspected as others in this area of research. Further, perceptive processes do not happen in neutral context. Thus, in our first empirical experiment in the laboratory we include also physical and linguistical components. The change of material entails also a significant change in the objects' aesthetics, and in turn in their attractiveness. This latter feature, particularly, is what we hypothesize to possibly have a crucial role in our interaction with things and with the world in general, and for this reason we connected our investigation with the field of Empirical Aesthetics and its research on beauty and emotions.

Beauty, indeed, is one of the protagonists of my whole three-year project, the *leitmotiv* of my journey that crosses most of the studies and phases of the present work, and the reason for this choice belongs to some background convictions. One of them is that, when an object or an environment is perceived as beautiful, it is often linked to feelings of pleasure, satisfaction, and positive affect, which can motivate further engagement with that object or environment. In the context of sustainable choice, aesthetic experiences of beauty can induce feelings of attachment or connection to what it is perceived, thus motivating individuals to care for it. For example, individuals may be more likely to engage in behaviors such as conserving resources, reducing waste, or supporting sustainable practices if the products or systems they encounter are aesthetically pleasing and harmonious with their values. To use Norman's words:

If beauty, pleasure, and fun are so essential to our lives, so essential to the design of products and services, then we had better come to understand these concepts. It is not enough that we build products that function, that are understandable and usable, we also need to build products that bring joy and excitement, pleasure and fun, and, yes, beauty to people's lives. (Norman, 2004: 2)

Pleasure and positiveness that come from the perception of beauty are not vital, yet they are essential to our lives. One of the main conclusions of this thesis is the idea that, in order to limit the consumption of objects and rather entice their reuse or re-purposing, they must also

satisfy the aesthetic need of human beings and serve as *aesthetic nourishment* (Harper & Simonsen, 2017). In fact, one of the main criteria of sustainable design concerns convincing people to buy fewer products but which are more resistant to the passage of time, both in terms of quality and aesthetic expression, a principle that thus ties in with the fundamental goal of sustainable aesthetics. The word *nourishment* in this case aims to link the body and mind with the aesthetic experience that is accompanied by a feeling of pleasure. In this sense, the sustainability of an object is not only related to its durability, functionality, or the fact that it can be reused or repaired, but also to the attraction and aesthetic value that object has for us: “Aesthetically sustainable products are precisely characterized by affording the recipient aesthetic nourishment” (Ibid., p. 124). The satisfaction of this need occurs when we are moved by the beauty of the things around us. Thus, sustainable aesthetics does not rely merely on subjective experiences and awareness of the ecological value and functions of an object, but also on the emotional attachment to it, which is what contributes to form and increase its actual value.

Our preferences and beliefs are intimately related to the meaning that we construct on things of the world, and these are what finally move us, the motivations that form our goals and guide our actions. Therefore, beauty is a tool that can be used to shape individuals' emotional responses toward environmental sustainability. For instance, a product that is visually appealing due to its natural and eco-friendly design may invite the user to engage with it more actively and with greater care. Our first study shows indeed a strong instinctive connection between sustainable-pleasurable objects and interaction with others, suggesting that in a social context we would use it more than the respective non-sustainable familiar alternative.

All in all, this should push product designers and engineers to make sustainable things that are not only functional but beautiful. If a product made from recycled materials is also aesthetically pleasing, it may not only afford use (as a functional object) but also afford pleasure, reinforcing the choice to buy and use that product. This dual affordance, the functional and the emotional, can serve to promote sustainable habits. Both cognitive science and aesthetics point to the idea that aesthetic attractiveness of beauty activates multiple cognitive and emotional systems. When this is applied to sustainable design of objects, it can make the affordances for sustainable behavior more apparent and emotionally compelling. The emotional response strengthens the cognitive affordance that the product has in alignment with one's personal or societal values, making sustainable behaviors more appealing and accessible. Policymakers could encourage the integration of aesthetics into sustainable design initiatives

by supporting grants, regulations, and incentives that prioritize the work of product designers for the visual appeal of sustainable materials and objects. This can help create a cultural shift where sustainability is not just a functional necessity but also a source of beauty and enjoyment. By designing products and environments that are not only functional but also aesthetically pleasing, we can foster a deeper connection to sustainability and encourage behaviors that contribute to the well-being of the planet.

Our perception of beauty starts with an initial hit, an impression and a sudden call for attention that derives from our instinctive attraction, guided by our sense of beauty. The more we are attracted to the object, the more we will be intrigued by it and want to discover it, and this will consequently lead us to act. It is precisely in this process that affordances and aesthetic experience can be linked: the more powerful the interaction is, the more I will be inclined to change. Therefore, a positive outcome of the first impression may be crucial for consequential interactions, but this is just part of the story.

What we are as individuals, our knowledge and experience, our culture and our habits, are implicitly part of our perception from the very beginning, even if more in an unconscious way. When it comes to making judgements, decisions, and actions, we are instead completely conscious. This means that in relation to sustainable behavior our cognitive and affective mechanisms meet many other features such as our expectations and motivations, as well as our values and beliefs. The aesthetic experience with art is said to be so powerful to be able to influence and shape these values. Though, these effects can be difficult to measure. We first examined whether an aesthetic experience as powerful as music can bring an emotional response in people that feel far from that specific type of experience, and we found out that a new medium such as virtual reality may enhance interest through novelty, thus intervening with expectations. At the same time, different modalities entail different contexts, and the change in motivations related to both elements may be crucial for the final outcome of aesthetic experience, thus leading to contingent and sometimes unexpected modulations.

Novelty and expectations are two elements that influence our general perception and interaction with the world, and they somewhat played a role also in the first study as well, where we opposed the power of familiarity with the effect of the new and unusual, and despite the former is known to have a strong grip on our attention, the second one is what arouses our curiosity and invites us to learn something new, producing eventually a greater pleasure than the one coming from familiar stimuli. Hence, there is a significant transformative power for

novelty within aesthetic experience, both with objects and art, and it is perhaps related to our expectations and to our knowledge instinct, both possibly affected by beauty. Once we notice the new and the unexpected captures our attention challenging our knowledge, we then start to elaborate the new input based on our priors, as the predictive processing account suggests. The outcome of our experience will depend then on our sense making. Sense-making is the process through which the agent selects the way of interaction that could be the most appropriate for its own viability, and in consequence, for its autonomy. The emergence of sense-making, then, is connected to what makes agents do one thing rather than another. Sense making plays a fundamental role in our encounter with art, in which cognitive mechanisms interchangeably communicate with the affective ones.

Several models show us that the emotional-affective processes associated with aesthetic experience influence the outcome of it from the outset, attracting attention and thus increasing the possibility of cognitive reflection on the stimuli, and in turn motivate action. This is the type of process we then investigated for environmental art. Art can trigger both positive and negative emotions. We know that positive emotions and the exposure to aesthetically pleasing landscapes or natural settings can increase people's willingness to engage in conservation efforts and motivate individuals to act in ways that preserve the environmental causes. Negative emotions, in turn, may lead to action by increasing risk perception. There is evidence that negative emotional states can lead to greater involvement and thus it is sometimes believed to be an effective tool toward climate change issues. Though, emotions are just one side of the coin. Cognitive pathways are also important. Often the most positive and effective emotional reactions are found for those artworks that include something personal, or if the problem is presented in a way that allows us to “read” it and receive it more deeply. Indeed, art is a form of communication that provides viewers with the space to find their own meaning and truth. Perhaps, then, if positive emotions prompt deeper cognitive engagement they may have a stronger effect than negative ones, which instead may result detrimental for action. In the study presented here, environmental artworks negatively framed did not spark a great emotional reaction, although they were considered very meaningful for the self and for society. This led us to assume that powerful content may not be enough to motivate us to act. With the addition of descriptive information we see that the affective response may increase, though this change may take different directions according to the type of artistic style, sometimes even decreasing the impact of beauty and the overall cognitive judgement. Certainly, affection and reflection need to work together in order to create a significant change in our intentions and behaviors.

However, it will always evidently depend also on the context and the medium through which we experience art, and digital reproductions of environmental artworks may not bring to the outcome the aim to, consequentially not receiving the attention they deserve and thus resulting way less effective than they could be.

Furthermore, behavior is always strictly connected with each own beliefs and values. In regard to environmental issues, often the lack of public emotional involvement has been linked to inaction on climate change and other environmental changes of global concern. Aesthetic experiences can heighten awareness of environmental issues and prompt individuals to reflect on their own role in environmental degradation. When people find beauty and value in natural or built environments, they may be more likely to understand the importance of preserving them. This can lead to an increase in behaviors such as recycling, reducing waste, or supporting sustainable policies. Though, these possible outcomes will depend in turn on how strong the emotional response will spark our cognitive reflection, and how both intertwine with our individual traits. Aesthetic experiences that align with each own environmental values may shape the individual's pro-environmental behavior, but a precise formula for a straightforward effect is not yet understood. Climate change and sustainability issues have a peculiar resonance for our psychological processes. Environmental art can indeed provide a space in which a freer encounter with scientific findings is possible, an alternative and exploratory means to approach reality and expand our understanding, as well as the use of new technologies (e.g., VR and AI) which I have advantageously used in several of the studies reported. Both elements, art and technology, can advance the science of sustainability by embracing transdisciplinarity and converting conventional epistemologies into practical, embodied, and emotional domains, but more and further investigations are needed.

I believe that Art inspired by environmental change can be positively correlated with its audience's support for climate action, as well as beauty and aesthetic pleasure can serve as a tool for emotional engagement, which in turn can be the motivator for the adoption of pro-environmental intentions and behaviors. Though, we all change our preferences according to our experience, and certain ways to communicate the urgency of this issue don't seem to work anymore. Maybe environmental art needs to find new ways of engagement, moving away from the classical images and negative catastrophic frames, which may still work for some, but they finally don't seem to bring to a real solution.

Aesthetic experience, whatever that can mean, will always be, first and foremost, about people's lives. Human beings change continuously, and they will always be looking for the

new. Likewise, they will always look for pleasure, since it is the lifeblood of existence. Our knowledge and our preferences will always be attracted and modulated from the new and the beautiful, hence, perhaps this is the time in which we need to move on and conceptualized a brand new engagement, new ways of emotional and cognitive involvement that can touch as deep as possible our everyday lives, and induce that very global change that we need in order to save the world.

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APPENDIX

A) Study 2 – Aesthetic Experience and Emotions

1. Aesthemos, Networked Minds Measure of Social Presence and TAMIG

1.1. Aesthemos

“What 'emotional effect' did the concert have on you?

For each emotion described in the list below, we kindly ask you to indicate with a cross answer (from 1, "not at all agree," to 5, "very much agree") that best corresponds to your experience during the concert "Amarcord d'un tango". There are no right or wrong answers. The emotional experience of a concert (e.g., intensity and type of emotions felt) is indeed absolutely personal: it is therefore important that in your answers you indicate only how you actually felt (e.g., you may choose 'not at all' for all items on the list that refer to emotions that do not correspond to what you personally felt). Please indicate with a check mark how much the following statements describe your emotional experience during the concert.

Emotional feelings 1 (not at all agree) 2 3 4 5 (very much agree)"

1 I found it beautiful	22 It amused me
2 It stimulated me intellectually	23 It saddened me
3 It delighted/ cheered me up	24 I felt confused
4 It calmed me down	25 It made me aggressive
5 It made me curious	26 It made me feel emotionally involved
6 I enjoyed it	27 It worried me
7 It fascinated me	28 It made me feel nostalgic
8 I experienced something wonderful	29 It surprised me
9 It invigorated me	30 It made me feel oppressed
10 I was mentally engaged	31 I found it sublime
11 It baffled me	32 It motivated me
12 I found it ugly	33 I felt indifference
13 I sensed a deeper meaning	34 I was impressed
14 I felt deeply moved	35 I found it unpleasant/unpleasant
15 It made me feel melancholy	36 It affected me
16 It gave me energy	37 It was disturbing to me
17 It made me angry	38 It piqued my interest
18 I was enchanted	39 It made me happy

19 It bored me	40 I felt awe
20 It relaxed me	41 It moved me to action
21 I felt a sudden insight	42 It was fun for me

COMMENTS/SUGGESTIONS:

Please enter here any comments and suggestions you have about the questionnaire, and/or about your overall experience of the concert and participation in the research.

Original questionnaire administered to Italian participants:

	Indichi con una crocetta quanto le seguenti affermazioni descrivono il suo vissuto emotivo durante il concerto.				
Sensazione emotiva	1 per nulla d'accordo	2	3	4	5 molto d'accordo
1 L'ho trovato bellissimo	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2 Mi ha stimolato intellettualmente	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3 Mi ha deliziato/ rallegrato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4 Mi ha calmato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5 Mi ha fatto incuriosire	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6 Mi è piaciuto	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7 Mi ha affascinato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8 Ho provato qualcosa di meraviglioso	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9 Mi ha rinvigorito	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10 Ero mentalmente impegnato/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11 Mi ha sconcertato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12 L'ho trovato brutto	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13 Ho percepito un significato più profondo	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Sensazione emotiva	1 per nulla d'accordo	2	3	4	5 molto d'accordo
14 Mi sono sentito/a profondamente commosso/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15 Mi ha fatto sentire malinconico/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
16 Mi ha dato energia	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
17 Mi ha fatto arrabbiare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18 Sono rimasto/a incantato/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19 Mi ha annoiato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
20 Mi ha rilassato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
21 Ho sentito un'improvvisa intuizione	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22 Mi ha divertito	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
23 Mi ha rattristato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24 Mi sono sentito/a confuso/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
25 Mi ha reso/a aggressivo/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
26 Mi ha fatto sentire emotivamente coinvolto/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
27 Mi ha preoccupato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
28 Mi ha fatto sentire nostalgico/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
29 Mi ha sorpreso	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
30 Mi sono sentito/a oppresso/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
31 L'ho trovato sublime	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
32 Mi ha motivato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
33 Ho provato indifferenza	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
34 Ero impressionato/a	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
35 L'ho trovato sgradevole/spiacevole	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
36 Mi ha colpito	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
37 Era inquietante per me	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
38 Ha suscitato il mio interesse	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
39 Mi ha reso felice	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
40 Ho provato soggezione	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
41 Mi ha spinto ad agire	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
42 Era divertente per me	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

1.2. Social Presence

Note: With respect to the original questionnaire Networked Minds Measure of Social Presence (Biocca et al, 2001). we eliminated the items on Mutual assistance and Dependent action as

inadequate to assess social presence during a concert in a theater, where spectators are not interacting in collaborative actions.

“What was your social involvement during the concert?

We present below some statements that refer to your social experience referring to the other(s) Spectators during the concert "Amarcord d'un tango". For each statement, we kindly ask you to indicate with a cross if/how much you agree (from 1, "not at all agree," to 5, "very much agree"). In answering, keep in mind that there are no right or wrong answers: it is important to answer spontaneously. Please indicate with a cross how much the following statements describe your 'social experience' during the concert.

My social experience 1 (not at all agree) 2 3 4 5 (very much agree)”

1 During the concert, I just noticed the presence of another person (more or less close to me) 2 Other people noticed me 3 I was often aware of the presence of other people in the surrounding space 4 Other people were often aware of my presence in the surrounding space 5 I think other people often felt like they were alone 6 I often felt like I was alone 7 I sometimes pretended to pay attention to other people 8 Other people sometimes pretended to pay attention to me 9 Other people paid a lot of attention to me 10 I paid a lot of attention to other people 11 The person next to me was easily distracted when "other things" (than the concert) were happening around us 12 I was easily distracted when "other things" (than the concert) were happening around us 13 Other people tended to ignore me 14 I tended to ignore other people 15 My reactions were clear to other people	16 Other people's reactions were clear to me 17 My thoughts were intuitable to other people 18 Other people's thoughts were intuitable to me 19 When I was happy, other people were happy too 20 When other people were happy, I was also happy 21 Other people were influenced by my mood 22 I was influenced by other people's moods 23 Other people's mood did not affect me 24 My mood did not affect other people's moods 25 My actions were dependent on other people's actions 26 Other people's actions were dependent on mine 27 My behavior sometimes occurred in reaction to other people's behavior 28 Other people's behavior sometimes happened in reaction to mine 29 What other people did affect what I did 30 What I did affected what other people did

COMMENTS/SUGGESTIONS:

Please enter here any comments and suggestions you have about the questionnaire, and/or about your overall experience of the concert and participation in the research.

Original questionnaire administered to Italian participants:

	Indichi con una crocetta quanto le seguenti affermazioni descrivono la sua ‘esperienza sociale’ durante il concerto.				
Mia esperienza sociale	1 per nulla d’accordo	2	3	4	5 molto d’accordo
1 Durante il concerto, ho appena notato la presenza di un’altra persona (più o meno vicina a me)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2 Le altre persone mi hanno notato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3 Ero spesso consapevole della presenza di altre persone nello spazio circostante	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4 Le altre persone erano spesso consapevoli della mia presenza nello spazio circostante	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5 Penso che le altre persone si siano sentite spesso da sole	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6 Mi sono sentito spesso come se fossi da solo	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7 Qualche volta ho fatto finta di prestare attenzione alle altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8 Le altre persone qualche volta hanno fatto finta di prestare attenzione a me	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9 Le altre persone hanno prestato molta attenzione a me	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10 Ho prestato molta attenzione alle altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11 La persona accanto a me veniva facilmente distratta quando accadevano “altre cose” (rispetto al concerto) attorno a noi	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

12 Io venivo facilmente distratto/a quando accadevano “altre cose” (rispetto al concerto) attorno a noi	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13 Le altre persone tendevano a ignorarmi	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

14 Io tendevo ad ignorare le altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15 Le mie reazioni erano chiare alle altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
16 Le reazioni delle altre persone mi erano chiare	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
17 I miei pensieri erano intuibili per le altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18 I pensieri delle altre persone erano intuibili per me	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19 Quando ero felice, anche le altre persone erano felici	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
20 Quando le altre persone erano felici, anche io ero felice	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
21 Le altre persone erano influenzate dal mio umore	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22 Io ero influenzato dall’umore delle altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
23 L’umore delle altre persone non mi ha condizionato	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24 Il mio umore non ha condizionato le altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
25 Le mie azioni erano dipendenti da quelle delle altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
26 Le azioni delle altre persone erano dipendenti dalle mie	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
27 Il mio comportamento a volte avveniva in reazione a quello delle altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
28 Il comportamento delle altre persone a volte avveniva in reazione al mio	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
29 Quello che facevano le altre persone influiva su ciò che facevo io	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
30 Quello che facevo io influiva su ciò che facevano le altre persone	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

COMMENTI/SUGGERIMENTI:

Inserite qui eventuali commenti e suggerimenti sul questionario e/o sulla vostra esperienza complessiva del concerto e della partecipazione alla ricerca.

1.3. Follow-up questionnaire: Theater Attendance, Media Habits, Immersiveness and Interest Gain (TAMIG)

Question	Question Type	Possible Answers
Theater Attendance		
F1. Are you a theatergoer/frequent attendee?	Yes/No Question	• Yes • No
F2. How often do you go to the theater?	4-Points ordinal scale	• At least once a year; • At least once every six months; • At least one time per month; • More than one time per month)
Media Habits		
F3. Have you ever listened to a Tango concert in the theater?	Yes/No Question	• Yes • No
F4. Try to specify why you do or do not frequent the theater.	Open Question	Open Question
F5. Have you ever seen the video of a concert?	Yes/No Question	• Yes • No
F6. Have you ever watched a video of a Tango concert?	Yes/No Question	• Yes • No
F7. In your estimation, how many minutes would you spend watching the video of a concert? *	Open Question	Open Question
F8. What are the minimum minutes that would make you consider a video to be long?	7-Point ordinal scale	• 1 minute; • 3 minutes; • 5 minutes; • 5 minutes; • 10 minutes; • 20 minutes; • 30 minutes; • 40 minutes
F9. Following the previous question, would you be predisposed to watch a concert video that exceeds 10	5-Points Likert Scale	• 1; • 2; • 3;

minutes?		• 4; • 5;
F10. After the experiment, would you have continued watching the video beyond the proposed 9 minutes?	Yes/No Question	• Yes • No
F11. Before this experiment, have you ever had experiences with immersive virtual reality tools?	Yes/No Question	• Yes • No
F12. Before this experiment, have you ever had virtual reality experiences with a smartphone?	Yes/No Question	• Yes • No
F13. Before this experiment, have you ever had virtual reality experiences with HTC-Vive?	Yes/No Question	• Yes • No
Immersiveness and Interest Gain		
F14. Before the experiment, how interested were you in Tango music?	5-Points Likert Scale	• 1; • 2; • 3; • 4; • 5.
F15. After the experiment, how interested were you in Tango music?	5-Points Likert Scale	• 1; • 2; • 3; • 4; • 5.
F16. In which mode did you watch the video for the experiment?	3-Points Categorical Scale	• HVR • MV • CVR
F17. I felt present in the virtual environment.	5-Points Likert Scale	• 1; • 2; • 3; • 4; • 5.
F18. I was not aware of the real environment around me.	5-Points Likert Scale	• 1; • 2; • 3; • 4; • 5.

F19. I was completely captured by the virtual world.	5-Points Likert Scale	• 1; • 2; • 3; • 4; • 5.

* Item F7 is asked only if F5 had positive outcome.

Original questionnaire administered to Italian participants:

Domanda	Tipologia di domanda	Risposte possibili
Frequenzazione Teatro		
F1. Sei un frequentatore/frequentatrice del teatro?	Domanda Sì/No	• Sì • No
F2. Quanto spesso vai a teatro?	Scala 1-4	• Una volta all'anno; • Almeno una volta ogni sei mesi; • Almeno una volta al mese; • Più volte al mese
F3. Hai mai ascoltato un concerto di Tango a teatro?	Domanda Sì/No	• Sì • No
F4. Prova a specificare per quale motivo frequenti o non frequenti il teatro.	Domanda aperta	Domanda aperta
Esperienza personale con media e strumenti immersivi		
F5. Hai mai visto il video di un concerto?	Domanda Sì/No	• Sì • No
F6. Hai mai visto il video di un concerto Tango?	Domanda Sì/No	• Sì • No
F7. Secondo una tua stima, quanti minuti passeresti a vedere il video di un concerto? *	Domanda aperta	Domanda aperta

F8. Qual è il minimo minutaggio che ti fa considerare che un video sia lungo?	Scala 1-7	• oltre 1 minuto; • oltre 3 minuti; • oltre 5 minuti; • oltre 10 minuti; • oltre 20 minuti; • oltre 30 minuti; • oltre 40 minuti
F9. Seguendo la domanda precedente, saresti predisposto a guardare un video di un * concerto che superi i 10 minuti?	Scala 1-5	• 1; • 2; • 3; • 4; • 5.
F10. Dopo l'esperimento, Avresti continuato a guardare il video oltre i 9 minuti proposti??	Domanda Si/No	• Si • No
F11. Prima di questo esperimento, hai mai avuto esperienze con strumenti immersivi per la realtà virtuale?	Domanda Si/No	• Si • No
F12. Hai mai avuto prima delle esperienze di realtà virtuale con lo smartphone? (cardboard)	Domanda Si/No	• Si • No
F13. Hai mai avuto prima delle esperienze di realtà virtuale col visore HTC? (casco di realtà virtuale immersivo)	Domanda Si/No	• Si • No
Immersività e aumento d'interesse		
F14. Prima dell'esperimento, quanto eri interessato alla musica Tango?	Scala 1-5	• 1; • 2; • 3; • 4; • 5.
F15. Dopo l'esperimento, quanto eri interessato alla musica Tango?	Scala 1-5	• 1; • 2; • 3; • 4; • 5.

F16. In quale modalità hai guardato il video per l'esperimento?	Scala categoriale	• Col visore HTC-Vive (casco montato sulla testa) MV • Tramite Google Cardboard (smartphone) • Schermo del computer
F17. Mi sentivo presente nell'ambiente virtuale.	Scala 1-5	• 1; • 2; • 3; • 4; • 5.
F18. Non ero consapevole dell'ambiente reale che mi circondava.	Scala 1-5	• 1; • 2; • 3; • 4; • 5.
F19. Ero completamente catturato dal mondo virtuale	Scala 1-5	• 1; • 2; • 3; • 4; • 5.

* Item F7 era chiesto solo con risposta positive alla domanda F5.

B) Study 3 – Aesthetic Experience and Environmental Art

1. Participants' educational background information

Only the participants that did the experiment in German had the opportunity to fill out information about their highest degree of education: 55% went to General secondary school, 20% went to University/University of applied sciences (College), 22% went to Vocational secondary school (with Matura). The three participants that answered "Other" did: an "Abitur in Germany", "Secondary school for art and design with Matura (vocational secondary school with a focus on art)" and "Abitur". Our sample was mainly composed of non-experts in art as 93.87% of the participants did not study art or art history. Three participants had a degree ("Language and Literature studies, which included an Aesthetics course"; "BA in Art and music theory, BA contemporary art"; "MA applied human rights"); and seven were still studying.

2. Stimuli

2.1.Credits

© Alejandro Durán 2010-2023, <https://alejandroduran.com/>

© Benjamin Von Wong, <https://www.vonwong.com/>

Giant Plastic Tap © Benjamin Von Wong #TurnOffThePlasticTap

TurnOffThePlasticTap © Von Wong Productions

Turn off the Plastic Tap project: <https://turnofftheplastictap.com/>

Plastikophobia project: <https://plastikophobia.com/>

Mermaid plastic project: <https://blog.vonwong.com/mermaidplastic/>

Truck load of plastic project: <https://blog.vonwong.com/truckloadofplastic/>

Original source of the photos:

<https://alejandroduran.com/washedupphotoseries>

Turn off the plastic cap project:

<https://www.dropbox.com/scl/fo/wv28axhi25jxxxl8xi7d/AE2asziCzJBzNJPc6RuCw50?rlkey=ewx40l3rruvcknb2s3ppxggcc&e=1&dl=0>

https://www.dropbox.com/sh/3l3cp0t8cjms1f0/AABtpXdOyMkvG5fQz_x0lH0Ga?e=1&dl=0

Plasstikophobia:

<https://www.dropbox.com/scl/fo/iyip6lydw36l8q8inno1d/AKfUc18TNQskUSy90lSKI7s?rlkey=gwi1fvmnu7h0b8gus4975bggw&e=1&dl=0>

Mermaid plastic :

<https://www.dropbox.com/scl/fo/3b2s64vui0cswkyr1fvne/AOJKrqdj602i44EppUp56sQ?rlkey=mcylrpcj0z1dryvytcxonhi8k&e=1&dl=0>

Truck load of plastic project:

<https://www.dropbox.com/scl/fo/cd5m6s76i6q8ugdtkxavnb/AEL-0OVvG7FPS9cHzFbWKA?rlkey=a4wy52h5fcmvzbl9qz1whrb54&e=1&dl=0>

2.2. Complete list of artworks.

2.2.1. Environmental artworks (EAc).

1. Alejandro Duran, Algas (Algae), 2013, Washed up photo series
2. Alejandro Duran, Amanecer (Dawn), 2011, Washed up photo series
3. Alejandro Duran, Atardecer (Sunset), 2013, Washed up photo series
4. Alejandro Duran, Bombillas (Bulbs), 2013, Washed up photo series
5. Alejandro Duran, Riachuelo (Brook), 2017, Washed up photo series
6. Alejandro Duran, Rayo (Ray), 2018, Washed up photo series
7. Alejandro Duran, Gota (Drop), 2011, Washed up photo series
8. Alejandro Duran, Mar (Sea), 2013, Washed up photo series
9. Alejandro Duran, Nubes (Clouds), 2011, Washed up photo series
10. Benjamin Von Wong, Final 3 (modified) 2018, Truck load of plastic
- 11 Benjamin Von Wong, Final 2, 2019, Plastikophobia,
12. Alejandro Duran, Rayo (Ray), 2011, Washed up photo series
13. Benjamin Von Wong, Final 4 (modified), 2018, Truck load of plastic
14. Benjamin Von Wong, Plastic Beach (Final 4), 2021, Turn off the Plastic Tap
15. Benjamin Von Wong, Plastic Playground (Final 2), 2021, Turn off the Plastic Tap
16. Alejandro Duran, Vena (Vein), 2011, Washed up photo series
17. Alejandro Duran, Viento de Jade (Jade Wind), 2011, Washed up photo series
18. Benjamin Von Wong, Plastic Mermaid 2 (Plastic Beach), 2016, Mermaid plastic

Note: for the Nature condition (Nc), images from EAc have been modified with Adobe Photoshop generative fill tool. Only artworks n° 11 and 18 were not modified, since they were not made within a natural environment but in studio. To substitute these two artworks, we selected two pictures consisting in a realistic representation of what depicted in those work of fantasy, namely: a men swimming underwater in a real sea, and a woman lying (alive) in a sandy coast (both recalling the same image perspective of the two artworks by Benjamin Von Wong).



Figure (i). Figures A, B, and C are artworks by Duran, whereas D, E, and F are the respective modified images used for Nc.

2.2.2. *Non-environmental artworks (ABLc).*

Note: these artworks were included also in the EAc and in the Nc in which they are meant as distractors. Indeed, if we would had shown only the environmental artworks or the pictures of nature, the goal of the study would have been too obvious starting from the very beginning, and that could have biased the answers. Instead, although we did not hide that the study involved art and environment, we gave as explicit focus for the participants the evaluation of Beauty and Meaningfulness in relation to each stimulus. At the same time, we did not want the distractors to (cognitively and emotionally) affect the experience, so we opted for unfamiliar abstract artworks which are usually less cognitively understandable and emotionally engaging

for lay art viewers compared to representational art. Indeed, we are confident in our manipulation choice since results showed that the ABLc was always the less engaging, and Beauty and Meaningfulness responses to these stimuli (Table S6) confirm our interpretation.

1. Ju Ting, Coral, 2020–2021, acrylic, cinder block, 49x49x33 cm
2. Anish Kapoor, *1000 names* (1981; 122 x 183 x 183 cm; Madrid, Museo Reina Sofia)
3. Anish Kapoor, *Installation view*, Imperial Ancestral Temple: 11th November–28th December 2019, Beijing, China
4. Beatriz Milhazes, *Moreno*, 2005, acrylic on canvas, 299 cm x 299.5 cm, Coleção Ailton Queiroz, Fortaleza, Photo courtesy Stephen White © Beatriz Milhazes
5. Beatriz Milhazes, Benguelé, 2020, Acrylic on canvas, 240 x 400 cm, Photo Pepe Schettino
6. Monica Bonvicini, Belt Cloth #2, 2022, Leather male belts, bolts, steel, 240 x 160 cm, Photo: Jens Ziehe
7. Monica Bonvicini, BeltDecke #7, 2023, Black leather men's belts, rivet screws, oiled steel 227 x 124 cm, metal bar 180cm, Photo: Jens Ziehe
8. Monica Bonvicini, Time of My Life, 2020, Digital watches, stainless steel, mirror on MDF, 105 x 90 x 90 cm, Photo: Jens Ziehe
9. Glenn Brown, Lactate (Midwinter), 2020, Oil and acrylic on panel (rounded corners), 200 x 141 x 2.2 cm
10. Glenn Brown, A Sailor's Life, 2011, Oil on panel, 163 x 120 cm
11. Jorge Pardo, Pendant lamp, Cuba/USA, 2002, laser-cut and laminated plywood, inkjet vinyl over PVC 20 h x 22 dia in (51 x 56 cm)
12. Tobias Rehberger, Installation, *Home and Away and Outside*, Schirn Kunsthalle, Frankfurt, 2014, Photo: Norbert Miguletz
13. Tobias Rehberger, *Mother without child 5*, 2019, Fiber-reinforced plastic, paint, 110 x 36.7 x 39 cm
14. Tobias Rehberger, *Present for Carsten Höller*, 2016, Printed paper, Limestone, 33 x 37.5 x 37.5 cm

15. Tobias Rehberger, Installation (2), *Home and Away and Outside*, Schirn Kunsthalle, Frankfurt, 2014, Photo: Norbert Miguletz

16. Tobias Rehberger, *Special edition "Aschenbecher"*, on the occasion of the exhibition FAST NIE, 2022, PLA, 7x21x12

17. Ju Ting, Coral, 2020–2021, hollow brick, 51x60x40

18. Jorge Pardo, *Shiny Tables from J. Crew (Costa Mesa)/Piece for Fandra from Fandra*, 1991, 3/4" paintable plywood from Room 107 of the Art Center, plexiglass, double stick, Blum knock-down hardware, 45 x 30 x 14.5 inches

3. Variables complementary information

3.1. Pro-Environmental Intentions (PEI) variables

3.1.1. *Intention to change behavior* (Gansser & Reich, 2021/2023) (only consumption items)

In the future, I will try more often to:

1. repair damaged things.
2. buy used things.
3. buy less in general.
4. buy less non-durable and more high-quality products with a longer lifetime.
5. not to fly on vacation, but rather to stay in the region.
6. buying clothes from fair and sustainable production (with certificate).

strongly disagree - strongly agree

3.1.2. *Intentions for recycling 1* (Knussen et al., 2004)

1. How likely will you recycle within the next month? (not recycling - recycling everything)

3.1.3. *Intentions for recycling 2* (Davis & Pallister, 2002)

2. How likely will you recycle cans, bottles and paper on a fortnight basis? (highly likely - highly unlikely)

3.1.4. *Intentions for pro-environmental behavior* (Diessner, 2022)

1. How willing would you be to pay higher prices to protect the environment?
2. How willing would you be to pay higher taxes to protect the environment?
3. How willing would you be to accept cuts in your standard of living to protect the environment?
4. How willing would you be to do what is right for the environment, even when it costs more money or takes more time?

very unwilling - very willing

3.1.5. Intentions for Activism (Swim & Geiger, 2017)

1. How likely would you vote for a political candidate based upon their support of climate change policies?
2. How likely would you vote for a political candidate based upon their opposition to climate change policy?
3. How likely would you participate in civic engagement supporting action on climate change by:
 - a) attend a public meeting
 - b) write letters or emails to government officials
 - c) sign petitions.
4. How likely would you share with a friend a petition that supports climate change action?
5. How likely would you share with a friend information that supports climate change actions?

very unlikely - very likely

3.1.6. Distractors (used in the pre-and-post questionnaire with the other PEI variables)

1. We should invest more money in art.
2. People should care more about the meaning of art.

strongly disagree - strongly agree

3.2. Pro-Environmental Behavior (PEB) variable

Donations of a ticket, valid for a lottery of 100€. Participants were informed that, in case of donations, the money would go to an environmental association. We did not specify to which association the donation would have been made. Only two participants asked for this information, and the experimenter responded that the money would go to a project that aims at cleaning oceans from plastic. Indeed, the money were finally donated to the Ocean Clean Up project (for more detail visit the website <https://theoceancleanup.com/>).

3.3. Affective and cognitive measures of the aesthetic experience

3.3.1. Questions on the exposure session

3.3.1.1. Beauty

1. How beautiful did you think the image was?

3.3.1.2 Meaningfulness

1. How well did you understand the content of this image?
2. How much relevant is this image content to you personally?
3. How relevant do you think the image content is for society?

“1 = not at all” to “100 = extremely”

3.3.2. Post-exposure

3.3.2.1. *Whole experience (meaningfulness + beauty)*

1. To what extent was the experience of this experiment meaningful for you?
2. To what extent do you think the images were beautiful?

Not at all - extremely

3.3.2.2. *Cognitive reflecting* (from reflecting on the artwork by Klochner & Sommer, 2021)

1. This experience seems relevant to my daily life
2. This experience highlights consequences that affect me personally.
3. This experience makes me think about my own role in the community
4. This experience makes me more aware of my behavioral impact on the environment.

strongly disagree - strongly agree

3.3.2.3. *Emotional reaction* (from Klochner & Sommer, 2021)

1. To what extent did this experience bring up each of these feelings with you?

[**Positive (7)**]: Happiness, Hope, Awe, Surprise, Inspiration, relaxation, Enthusiasm

[**Negative (7)**]: Guilt, Sadness, disappointment, Helplessness, Anger, Anxiety, Shame

Not at all – extremely

3.4. Individual trait variables

3.4.1. Demographics

Name, Age, Gender, Education in art

3.4.2. NEP – New Ecological Paradigm (Dunlop et al., 2000) (German version: Schleyer-Lindenmann et al., 2018)

1. We are approaching the limit of the number of people the earth can support.
2. Humans have the right to modify the natural environment to meet their needs.
3. When humans interfere with nature, the consequences are often disastrous.
4. Human ingenuity will ensure that we do NOT make the earth uninhabitable.
5. Humans greatly abuse the environment.
6. The earth has abundant natural resources if only we learn to use them.
7. Plants and animals have as much right to exist as humans.
8. The balance of nature is strong enough to cope with the impact of modern industrialized nations.
9. Despite our special abilities, humans are subject to the laws of nature.
10. The so-called “ecological crisis” of mankind is greatly exaggerated.

11. Earth is like a spaceship with very limited space and resources.
12. Humans should rule over the rest of nature.
13. The balance of nature is very delicate and can be easily disturbed.
14. Humans will eventually learn enough about how nature works to be able to control it.
15. If things continue as they are, we will soon face a great ecological catastrophe.

strongly disagree - strongly agree

3.4.3. Attitude (Gansser & Reich 2023)

To behave sustainably for me is

1. very undesirable - very desirable
2. very bad - very good
3. very harmful - very beneficial
4. very unimportant - very important
5. very hard - very easy

3.4.4. Attitude toward recycling (de Groot & Steg, 2008)

I think that recycling plastic is:

1. bad-good
2. unnecessary-necessary
3. negative-positive
4. unimportant-important
5. useless-useful

3.4.5. Awareness of consequences (Davis et al., 2002)

I think that recycling household waste will:

1. protect the environment;
2. reduce landfill waste;
3. preserve natural resources;
4. conserve energy;
5. save money;
6. create a better environment for future generations

strongly disagree - strongly agree

3.4.6. Subjective Norm (Gansser & Reich 2023)

1. Most of the people who are important to me think that I should behave sustainably.
2. My family thinks I should behave in a sustainable way
3. My friends think I should behave in a sustainable way.

strongly disagree - strongly agree

3.4.7. Ascription of Responsibility (Davis et al., 2002) (just recycling questions)

1. recycling efforts of all households will reduce landfill;
2. recycling my household waste is always worth the effort;
3. It is up to all individuals to preserve them where they can
4. recycling will improve the quality of the environment.

strongly disagree - strongly agree

3.4.8. Perceived Behavioral Control 1 (Gansser & Reich, 2023)

1. For me, behaving sustainably is in general: completely impossible - very possible.
2. For me, behaving sustainably is financially: completely impossible - very possible.
3. For me to achieve a sustainable lifestyle is: very difficult - very easy.
4. If I wanted to, it would be easy for me to behave in a sustainable way: very unlikely - very likely.
5. The decision to behave sustainably is under my complete control: not at all – completely

3.4.9. Perceived Behavioral Control 2 (Knussen et al., 2004)

1. For me, recycling facilities are: easily available – not easily available

3.4.10. Past recycling 1 (Davis et al., 2002)

1. I have usually recycled my household waste in the past:

All – None

3.4.11. Past recycling 2 (Knussen et al., 2004)

1. how much of your household waste you have recycled in the last three months?

none of it - all of it

3.4.12. VAIK (PART 1) (Speacker et al., 2020)

Please indicate to what extent the following statements apply to you:

	not at all						very much
I enjoyed visiting art class in school	☐	☐	☐	☐	☐	☐	☐
I enjoy talking about art with others	☐	☐	☐	☐	☐	☐	☐
I have many friends/acquaintances who are interested in art	☐	☐	☐	☐	☐	☐	☐
I am interested in art	☐	☐	☐	☐	☐	☐	☐
I am always looking for new artistic impressions and experiences	☐	☐	☐	☐	☐	☐	☐
During my everyday life I spontaneously notice art objects that I find fascinating	☐	☐	☐	☐	☐	☐	☐
I come from a family that is interested in art	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐

Please indicate which answer best describes you:

	less than once per year	once per year	once per half-year	once every three months	once per month	once every fortnight	once per week or more often
How often do you visit art museums or art galleries on average?	☐	☐	☐	☐	☐	☐	☐
How often do you read books, magazines or catalogues about art?	☐	☐	☐	☐	☐	☐	☐
How often do you view images of artworks (picture books, internet, etc.)?	☐	☐	☐	☐	☐	☐	☐
How often do you visit events about art or art history (seminars, projects, festivals, etc.)?	☐	☐	☐	☐	☐	☐	☐

3.5. Other variables

3.5.1. Artistic intentions

1. How likely would you visit a museum now?

2. How likely would you see more artworks now?
3. How likely would you buy an artwork right now?

highly unlikely - highly likely

3.5.2. Familiarity with the artworks

1. Did you know any of the artworks? (Yes/no)
2. Can you name the artwork/s or the author/s that you knew?

3.5.3. Art Quality (Klochner & Sommer, 2021)

1. The images appear to be of considerable artistic quality

strongly disagree - strongly agree

3.5.4. Works of art

1. To what extent do you think the images were works of art?

Not at all – Extremely

3.5.5. Distractors (no analyzed)

1. This experience seems relevant for human rights
2. This experience seems relevant for the history of art.

strongly disagree - strongly agree

4. Analysis of the Catch trials

Participant attention toward the experiment was verified with an analysis of questions (“Catch Trials”). They were prompted to either answer 1 or 100 on the sliding bar. Six Catch Trials questions were incorporated in the EAc and Nc. Due to the different number of images to evaluate (see Figure 1 in the main manuscript for more information), ABLc only had three Catch Trials questions. After having a general overview of the participants that missed most of the Catch Trials questions, a set of error types were defined (reported in Table S0).

Table S0.	
<i>Description of the different types of identified errors to the “Catch Trials” questions</i>	
Name of Error type	Description
1. No Answer	Specific error for the Condition 3 participants.
2. Very Incorrect	A true mistake from the participant. Manifest by very random numbers with decimals (most of the time).
3. Incorrect but close	Possible “mouse error”. It seems that the participant read the question but did not go to the end of the sliding scale.

4. 100 instead of 1	“Attention error”. It seems that the participant did not really read the question.
5. 1 instead of 100	“Attention error”. It seems that the participant did not really read the question.
6. Close to 100 but expecting 1	Mix between an “attention error” and a “mousse error”. It seems that the participant did not read the question and then went almost to the end of the scale.
7. Close to 1 but expecting 100	Mix between an “attention error” and a “mousse error”. It seems that the participant did not read the question and then went almost to the end of the scale.

The different errors were then attributed to a degree of severity. Case 2 was the “most severe”; cases 4/5/6/7 were “moderately severe”, and case 3 was “lightly severe”. The exclusion rule was then as follows: (1) For EAc and Nc, if at least four out of six trials for one participant were “most severe” or “moderately severe”, the participant was excluded; (2) for ABLc, if at least two out of three trials for one participant were “most severe” or “moderately severe”, the participant was excluded. After application of the exclusion criteria participants 26, 63, 99, 113, 147 (ABLc); 2, 143 (EAc); 101 and 109 (Nc) were excluded from the final sample.

5. Descriptive statistics for the main DVs

Table S1.										
<i>Descriptive Statistics for the Intentions (grouped by conditions)</i>										
	Condition	Measure	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
Change Behavior - Gansser & Reich, 2023										
	ABLc	Pre	4.83	91.67	64.88	17.56	65.83	2.48	59.89	69.87
		Post	10.33	89.17	63.36	16.02	63.67	2.27	58.80	67.91
	EAc	Pre	18.00	93.50	66.04	14.49	69.00	2.01	62.00	70.07
		Post	31.33	97.83	63.80	14.65	63.17	2.03	59.72	67.88
	Nc	Pre	16.17	97.50	65.03	16.94	63.17	2.35	60.31	69.74
		Post	29.17	96.67	66.15	15.46	67.42	2.14	61.85	70.45
Recycling 1 - Knussen et al, 2004										
	ABLc	Pre	10	100	74.64	18.08	77.0	2.56	69.50	79.78
		Post	5	100	76.38	18.61	80.0	2.63	71.09	81.67
	EAc	Pre	2	100	65.02	24.99	69.0	3.46	58.06	71.98
		Post	9	100	70.96	21.40	73.0	2.97	65.00	76.92
	Nc	Pre	5	100	73.69	21.80	75.5	3.02	67.62	79.76
		Post	30	100	73.02	21.51	70.0	2.98	67.03	79.01
Recycling 2 - Davis et al., 2002										
	ABLc	Pre	0	100	57.10	35.12	63.5	4.97	47.12	67.08
		Post	0	100	57.92	34.75	64.5	4.91	48.04	67.80
	EAc	Pre	0	100	56.67	30.83	58.0	4.28	48.09	65.26

		Post	0	100	44.13	32.45	36.0	4.50	35.10	53.17
	Nc	Pre	0	100	46.75	33.49	46.0	4.64	37.43	56.07
		Post	0	100	47.38	34.83	44.5	4.83	37.69	57.08
Activism - Swin & Geiger, 2017										
	ABLc	Pre	11.86	84.43	49.21	16.10	48.14	2.28	44.64	53.79
		Post	10.86	80.00	46.30	17.97	46.14	2.54	41.19	51.41
	EAc	Pre	9.14	84.43	50.18	16.18	51.00	2.24	45.68	54.69
		Post	11.71	93.86	52.13	20.51	50.21	2.84	46.42	57.84
	Nc	Pre	10.71	86.86	47.44	20.46	49.14	2.84	41.74	53.13
		Post	12.57	90.57	52.28	19.44	52.64	2.70	46.87	57.69
Pro-Environmental behavior - Diessner et al., 2022										
	ABLc	Pre	8.50	90.50	61.15	17.74	59.75	2.51	56.10	66.19
		Post	11.75	98.75	59.22	20.42	60.88	2.89	53.41	65.02
	EAc	Pre	14.50	95.00	59.93	19.09	65.12	2.65	54.61	65.24
		Post	14.00	100.00	60.86	19.73	66.88	2.74	55.36	66.35
	Nc	Pre	17.50	98.25	61.88	17.88	62.00	2.48	56.91	66.86
		Post	12.50	97.50	60.40	20.48	59.38	2.84	54.70	66.10
<i>Note. Intentions to change behavior scores presented here are a mean value of six questions.</i> <i>Intentions for recycling scores presented here are from 2 different questions.</i> <i>Intentions for activism presented here are a mean value of seven questions.</i> <i>Intentions for pro-environmental behavior presented here are a mean value of four questions.</i> <i>N = 154.</i> <i>The range of possible data is from 0 to 100.</i>										

6. Descriptive statistics for the other variables

Table S2.									
Descriptive Statistics for the other variables (grouped by Condition)									
	Condition	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
Artistic quality									
	ABLc	7	94	50.74	21.99	47.00	3.11	44.49	56.99
	EAc	1	94	50.04	28.34	50.50	3.93	42.15	57.93
	Nc	0	100	47.15	25.76	50.00	3.57	39.98	54.33
Work of art									
	ABLc	5	100	64.72	22.39	62.5	3.17	58.36	71.08
	EAc	10	100	66.94	24.46	72.5	3.39	60.13	73.75
	Nc	4	100	57.31	27.29	60.0	3.78	49.71	64.91
Likelihood to visit more museums and see more art									
	ABLc	0.0	90.5	55.64	23.42	59.75	3.31	48.98	62.30
	EAc	3.5	100.0	55.67	23.39	58.75	3.24	49.16	62.18
	Nc	0.0	100.0	49.78	28.38	51.50	3.94	41.88	57.68
Likelihood likely to purchase artworks									
	ABLc	0	99	26.28	27.85	11.0	3.94	18.37	34.19
	EAc	0	100	24.94	26.36	14.5	3.66	17.60	32.28

Nc	0	85	24.77	24.45	18.5	3.39	17.96	31.57
<i>Notes.</i> <i>N = 154.</i> <i>The range of possible data is from 0 to 100.</i>								

7. Analysis of RQ1: Did the intentions to/for (1) changing behavior, (2) recycling, (3) activism, and (4) pro-environmental behavior, before and after the experiment differ across conditions?

The results of the ANCOVA (DVs: Post-measurement from each of the five variables representing the intentions; IV: Condition; Covariate: Pre-measurement from each of the five variables representing the intentions) are reported below. The “aov” function of the R base was used to run the parametric ANCOVA.

7.1. Intention to change behavior

Intention to change behavior after the experiment was set as DV, Intention to change behavior before the experiment was set as Covariate, and *Condition* was set as the between-subject factor variable. No statistically significant effect of *Condition* was found ($F(2,150) = 1.71, p = .18$): the *Condition* did not significantly influence the post score for the intentions to change behavior when accounting for the pre score.

7.2. Intention for recycling

As for the ANOVAs reported in the main text, the “lmrob” function was used to compute robust models for the ANCOVAs. In the models, Intention for Recycling1/2 after the experiment was set as DV, Intention to for Recycling1/2 before the experiment was set as Covariate, and *Condition* was set as the between-subject factor variable. Apart from the covariate, one other significant condition was found for Recycling 2 (the model with Condition 3 as reference). This results suggest that participants in Condition 1 showed significantly lower post intervention recycling behaviour compared to those in Condition 3 ($b = -16.66, SE = 6.76, t(31) = -2.46, p = .015$). No other statistically significant effect of *Condition* was found (see Table S3): the conditions did not significantly influence the post score for the intentions for activism when accounting for the pre score.

Table S3.					
Summary of the results of the ANCOVA models for the two variables representing Intention for recycling.					
		Estimate	SE	T value	P value
Recycling 1 – Model ABLc as reference					
	Condition Releveled EAc	1.09	2.57	0.42	0.67

	Condition Releveled Nc	-0.49	2.42	-0.20	0.84
	Covariate	0.73	0.057	12.86	< 2e-16 ***
Recycling 1 – Model Nc as reference					
	Condition Releveled EAc	1.57	2.50	0.63	0.53
	Condition Releveled ABLc	0.49	2.42	0.20	0.84
	Covariate	0.73	0.06	12.86	< 2e-16 ***
Recycling 2 – Model ABLc as reference					
	Condition Releveled EAc	-16.66	6.76	-2.46	0.015 *
	Condition Releveled Nc	-6.69	7.54	-0.89	0.38
	Covariate	0.51	0.15	3.32	0.001 **
Recycling 2 – Model Nc as reference					
	Condition Releveled EAc	-9.97	6.76	-1.47	0.14
	Condition Releveled ABLc	6.69	7.54	0.89	0.38
	Covariate	0.51	0.15	3.33	0.001 **
Note. $p < .05^*$, $p < .01^{**}$, $p < .001^{***}$					

7.3. Intention for activism

Intention for activism after the experiment was set as DV, Intention to for activism before the experiment was set as Covariate, and *Condition* was set as the between-subject factor variable. No statistically significant effect of *Condition* was found ($F(2,150) = 1.98$, $p = .14$): the conditions did not significantly influence the post score for the intentions for activism when accounting for the pre score.

7.4. Intention for pro-environmental behavior

Intention for pro-environmental behavior after the experiment was set as DV, Intention to for pro-environmental behavior before the experiment was set as Covariate, and *Condition* was set as the between-subject factor variable. No statistically significant effect of *Condition* was found ($F(2,150) = 0.66$, $p = .52$): the conditions did not significantly influence the post score for the intentions for pro-environmental behavior when accounting for the pre score.

8. Analysis of RQ3: Can the results for the intentions (RQ1) and behaviour (RQ2) be explained by the affective and cognitive properties of the images?

8.1. Whole experience

Table S4.									
Descriptive Statistics for the Emotions (grouped by Condition)									
	Condition	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
Happiness									
	ABLc	0	99	32.6	25.2	30	3.57	25.43	39.8
	EAc	0	65	14.3	16.7	8.5	2.32	9.69	19.
	Nc	0	100	35.3	24.6	31.5	3.41	28.44	42.1
Hope									

	ABLc	0	77	21.6	22.3	15	3.15	15.3	27.9
	EAc	0	71	22.3	22.9	14	3.17	15.8	28.6
	Nc	0	100	31.5	29.7	23	4.11	23.2	39.8
Awe									
	ABLc	0	90	19.6	23.3	11	3.3	13	26.3
	EAc	0	81	33.8	25.7	29.5	3.56	26.7	41
	Nc	0	100	29.4	30.9	19.5	4.29	20.8	38
Surprise									
	ABLc	0	100	30.8	26.5	23.5	3.75	23.2	38.3
	EAc	0	94	18.3	20.7	10	2.86	12.6	24.1
	Nc	0	86	26.5	26.2	20	3.63	19.3	33.8
Inspiration									
	ABLc	1	100	42.4	27.7	48.5	3.92	34.5	50.2
	EAc	0	81	40.4	25	40.5	3.47	33.4	47.4
	Nc	3	100	47,7	28.9	43.5	4	39.6	55.7
Relaxation									
	ABLc	0	97	36.2	28.6	32.5	4.04	28	44.3
	EAc	0	80	17.9	22	8.5	3.05	11.8	24
	Nc	0	100	42	27.6	40	3.82	34.3	49.7
Enthusiasm									
	ABLc	0	73	23.9	25.4	12.5	3.59	16.7	31.1
	EAc	0	100	51.1	29.2	51	4.05	43	59.2
	Nc	0	100	20.5	28.5	4	3.95	12.6	28.4
Positive Emotions Total									
	ABLc	1.57	64.7	29.6	15.8	28.8	2.23	25.1	34.1
	EAc	1.43	66.9	28.3	12.8	26.3	1.78	24.7	31.9
	Nc	8.57	94.9	33.3	17.3	30.3	2.39	28.5	38.1
Guilt									
	ABLc	0	69	17.7	20.2	9.5	2.85	11.9	23.4
	EAc	0	100	49.5	28	53	3.88	41.7	57.3
	Nc	0	100	22	25.7	10	3.57	14.8	29.2
Sadness									
	ABLc	0	84	17.1	21.4	6.5	3.02	11.1	23.2
	EAc	0	100	56.1	29.6	61	4.1	47.8	64.3
	Nc	0	89	18.6	24.6	6	3.42	11.7	25.4
Helplessness									
	ABLc	0	100	22.5	26.5	10.5	3.75	15	30
	EAc	0	100	48.1	31	49	4.3	39.5	56.8
	Nc	0	100	22.2	27.9	10	3.86	14.5	30
Anger									
	ABLc	0	75	10.3	18.2	1	2.58	5.16	15.5
	EAc	0	100	38.2	28.4	35.5	3.94	30.25	46.1
	Nc	0	91	13.4	22.4	3	3.1	7.16	19.6

Anxiety									
	ABLc	0	81	12.7	18.2	5	2.57	7.51	17.9
	EAc	0	99	42.3	29.1	40	4.03	34.2	50.4
	Nc	0	100	19	25.1	9.5	3.49	12.02	4.26
Shame									
	ABLc	0	90	16.8	23.5	4.5	3.32	10.17	23.5
	EAc	0	100	43.4	33	47.5	4.57	34.26	52.6
	Nc	0	100	14.5	24.3	3	3.36	7.73	21.2
Disappointment									
	ABLc	0	99	31.2	26.3	25.5	3.72	23.8	38.7
	EAc	0	92	25.9	25.8	18.5	3.58	18.7	33.1
	Nc	0	100	36.2	24.8	32.5	3.45	29.3	43.1
Negative Emotions Total									
	ABLc	0.29	56.4	18.3	14.3	15	2.03	14.3	22.4
	EAc	3.14	80.4	43.3	18.6	43.1	2.58	38.2	48.5
	Nc	2.14	91.9	20.8	19.2	13.9	2.66	15.5	26.2
<i>Notes. Positive Emotions is the average of the answers to the happiness, hope, awe, surprise, inspiration, relaxation, enthusiasm items. Negative Emotions is the average of the answers to guilt, sadness, disappointment, helplessness, anger, anxiety, shame items.</i> <i>N = 154.</i> <i>The range of possible data is from 0 to 100.</i>									

Table S5.									
<i>Descriptive Statistics for the affective (Beauty) and cognitive (Meaningfulness and Cognitive reflection) evaluation of the whole experience.</i>									
	Condition	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
Beauty									
	ABLc	5	83	41.5	19.4	41	2.74	36	47
	EAc	7	93	49.8	22.7	50.5	3.15	43.4	56.1
	Nc	3	100	56.9	21	60	2.91	51.1	62.8
Meaningfulness									
	ABLc	1	87	41.1	23.8	46.5	3.37	34.4	47.9
	EAc	0	89	53.2	20.7	54	2.87	47.5	59
	Nc	5	100	44.2	24	50	3.33	37.5	50.9
Cognitive Reflection									
	ABLc	0.5	90	44	23	44.4	3.26	37.4	50.5
	EAc	28.8	98.5	66.8	17.8	69.8	2.47	61.9	71.8
	Nc	1	100	51	27	52.9	3.75	43.5	58.5
<i>Notes.</i> <i>N = 154.</i> <i>The range of possible data is from 0 to 100.</i>									

8.2. For each image

Table S6.									
<i>Descriptive Statistics for the affective (Beauty) and cognitive (Meaningfulness - Understand Content, Personally Relevant, Society Relevant) evaluation for each image. .</i>									
	Condition	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
Beauty									
	ABLc	1	99.4	37.5	23.9	36.1	0.76	36	39
	Environ. Art in EAc	1	100	50.082.94	16.4	86.5	0.52	81.8	83.9
	Art in EAc	1	100	26.6	21.8	20.9	0.69	25.2	28
	Nature in Nc	5.26	100	80.1	18.4	84.7	0.59	79	81.3
	Art in Nc	1	100	39.9	27.8	34.2	0.89	38.2	41.7
Meaningfulness - Understand Content									
	ABLc	1	99.7	29.4	23.2	24.2	0.74	28	30.9
	Environ. Art in EAc	1	100	72.2	21.2	76	0.68	70.8	73.5
	Art in EAc	1	100	22.6	21.6	16.7	0.69	21.2	24
	Nature in Nc	1	100	55.9	26.3	59.6	0.84	54.2	57.6
	Art in Nc	1	100	28.7	27.4	19.6	0.88	27	30.4
Meaningfulness - Personally Relevant									
	ABLc	1	100	35.4	24.9	31.8	0.79	33.9	37
	Environ. Art in EAc	1	100	84.9	16	89.4	0.51	83.9	85.9
	Art in EAc	1	100	25.9	22.9	18.8	0.73	24.5	27.3
	Nature in Nc	1	100	62	26.3	65.1	0.84	60.4	63.7
	Art in Nc	1	100	34.3	28.9	25.4	0.93	32.5	36.1
Meaningfulness - Society Relevant									
	ABLc	1	100	44.1	24.4	44.2	0.775	42.5	45.6
	Environ. Art in EAc	1	100	45.9	25.9	45.3	0.831	44.3	47.6
	Art in EAc	1	100	45.6	25.1	46.2	0.806	44.1	47.2
	Nature in Nc	1	100	64.7	23.3	68.1	0.749	63.3	66.2
	Art in Nc	1	100	42.6	27.4	39.9	0.878	40.8	44.3

Notes.

$N = 154$.

The range of possible data is from 1 to 100.

Table S7.

Descriptive Statistics for the affective (Beauty) and cognitive (Meaningfulness - Understand Content, Personally Relevant, Society Relevant) evaluation grouped by Condition.

	Condition	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
Beauty									
	ABLc	1	99.4	37.5	23.9	36.1	0.76	36	39
	EAc	1	100	54.7	34.1	61.2	0.77	53.2	56.3
	Nc	1	100	60	31	67.1	0.7	58.7	61.4
Meaningfulness - Understand Content									
	ABLc	1	99.7	29.4	23.2	24.2	0.739	28	30.9
	EAc	1	100	47.4	32.7	49.5	0.743	45.9	48.8
	Nc	1	100	42.3	30.1	38.1	0.682	41	43.6
Meaningfulness - Personally Relevant									
	ABLc	1	100	35.4	24.9	31.8	0.79	33.9	37
	EAc	1	100	55.4	35.5	63.9	0.81	53.8	57
	Nc	1	100	48.2	30.9	50.4	0.7	46.8	49.6
Meaningfulness - Society Relevant									
	ABLc	1	100	44.1	24.4	44.2	0.76	42.5	45.6
	EAc	1	100	45.8	25.5	45.6	0.58	44.7	46.9
	Nc	1	100	53.6	27.7	57.8	0.63	52.4	54.9

Notes.

$N = 154$.

The range of possible data is from 1 to 100.

9. Analysis of RQ4: Can the results for the intentions (RQ1) and behaviour (RQ2) be explained by individual differences among participants (e.g., the NEP – New Ecological Paradigm)?

9.1. General overview of the variables

Table S8.

Descriptive Statistics for the Individual trait variables (not split by Condition).

	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
NEP								
	1.87	54.6	29.6	9.22	28.57	0.74	28.14	31.07
Attitude Sustainable behavior								
	28.40	100	77.18	13.1	79.7	1.06	75.1	79.27
Subjective Norm								
	0	100	58.38	24.72	63.67	1.99	54.44	62.31
Perceived Behav. Control								

	23.8	100	59.47	16.26	58.1	1.31	56.88	62.06
Perceived Behav. Control2								
	0	100	58.69	26.05	60.5	2.1	54.54	62.84
Attitude Recycle								
	25.8	100	91.06	13.44	96.6	1.08	88.92	93.21
Past Recycling1								
	0	100	47.57	30.35	46.5	2.45	42.74	52.40
Past Recycling2								
	0	100	58.57	25.84	62	2.08	54.46	62.68
Aware Consequences								
	18	100	68.24	18.29	70.58	1.47	65.33	71.15
Ascription Responsibility								
	23.5	100	70.59	17.14	73.25	1.38	67.87	73.32
VAIAK Interest								
	1.27	6.55	4.01	1.16	4.18	0.09	3.83	4.2
Notes.								
<i>N</i> = 154.								
<i>The range of possible data is from 0 to 100.</i>								

Table S9.									
<i>Descriptive Statistics for the Individual Trait variables (grouped by Condition)</i>									
	Condition	Min	Max	mean	sd	median	SE	lower.ci	upper.ci
NEP									
	ABLc	10	53.1	30.1	8.01	29.2	1.13	27.8	32.3
	EAc	11.07	53.6	29	9.82	27.4	1.36	26.3	31.7
	Nc	1.87	54.6	29.8	9.81	28.6	1.36	27	32.5
Attitude Sustainable behavior									
	ABLc	28.4	100	77.6	14.6	79.2	2.06	73.5	81.7
	EAc	36.6	100	75.2	13.1	78.3	1.82	71.5	78.8
	Nc	48.6	94.2	78.8	11.5	81.4	1.59	75.6	82
Subjective Norm									
	ABLc	4	100	60.5	22.5	62.7	3.18	54.1	66.9
	EAc	0	87.3	55.9	22.9	61.8	3.17	49.6	62.3
	Nc	0	100	58.8	28.5	65.3	3.96	50.8	66.7
Perceived Behav. Control1									
	ABLc	26.2	92.8	59.5	17.3	59.7	2.45	54.6	64.4
	EAc	30.4	100	58.6	16.2	56.4	2.24	54.1	63.1
	Nc	23.8	95.4	60.4	15.6	57.9	2.16	56	64.7
Perceived Behav. Control2									
	ABLc	9	100	61	25	67.5	3.54	53.9	68.1
	EAc	0	100	55.8	26.1	57	3.62	48.5	63
	Nc	9	100	59.4	27.2	60.5	3.77	51.8	66.9
Attitude Recycle									

	ABLc	25.8	100	88.3	15.91	93.4	2.25	83.8	92.8
	EAc	57.8	100	93.8	8.36	96.6	1.16	91.5	96.1
	Nc	46.4	100	91	14.63	100	2.03	86.9	95.1
Past Recycling1									
	ABLc	0	100	48.9	31.1	40.5	4.4	40.1	57.8
	EAc	0	100	49.1	30	50	4.17	40.8	57.5
	Nc	0	100	44.7	30.3	42	4.2	36.3	53.1
Past Recycling2									
	ABLc	0	100	61	24	65	3.39	54.1	67.8
	EAc	0	100	52.7	27.8	53	3.85	44.9	60.4
	Nc	2	95	62.2	25	70	3.47	55.2	69.2
Aware Consequences									
	ABLc	25.8	100	69.6	19.5	73.2	2.75	64	75.1
	EAc	34.7	100	66.7	15.5	66.7	2.15	62.3	71
	Nc	18	98.7	68.5	19.9	72.9	2.75	63	74.1
Ascription Responsibility									
	ABLc	27.5	94.2	70.8	16	73.5	2.26	66.2	75.3
	EAc	23.5	98.2	68.5	16.9	70.5	2.34	63.8	73.2
	Nc	27.8	100	72.6	18.5	77	2.56	67.4	77.7
VAIAK Interest									
	ABLc	1.45	6.55	3.91	1.21	3.95	0.17	3.57	4.25
	EAc	1.27	6.18	4	1.12	4.14	0.16	3.69	4.31
	Nc	1.45	6.27	4.13	1.15	4.23	0.16	3.81	4.45
<i>Notes.</i> <i>N = 154.</i> <i>The range of possible data is from 0 to 100.</i>									

C) Study 4 – Aesthetic Experience and Space

1. Landmarks

1.1. Directions panels (Map, Office Totem, Recycling panel, Toilet panel)

I luoghi

delle Serre dei Giardini

- 1 Aster (p 1)
- 2 Fondazione Golinelli (p 0)
- 3 Serra salotto
- 4 Spazio Eventi / events
- 5 Serra bar
- 6 Panche orto
- 7 Vetro
- 8 Botanical bar
- 9 Kw baby
- 10 Kworking (p 0/1)
- 11 Gabbia del leone
- 12 Kw info
- 13 Serra orto
- 14 Kw gARTen
- 15 Landmark
- 16 L'alba dell'uomo
- 17 Toilette
- 18 Fasciatoio / changing table

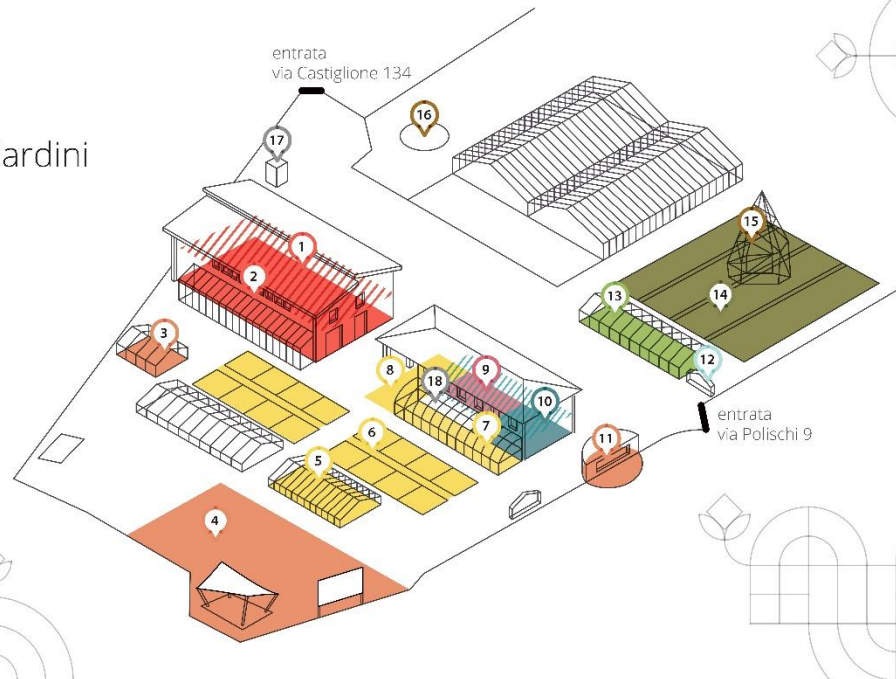


Figure 1S. Map of the Greenhouses outdoor space.



Figure 2S. Office Totem.



Figure 3S. Recycling panel.

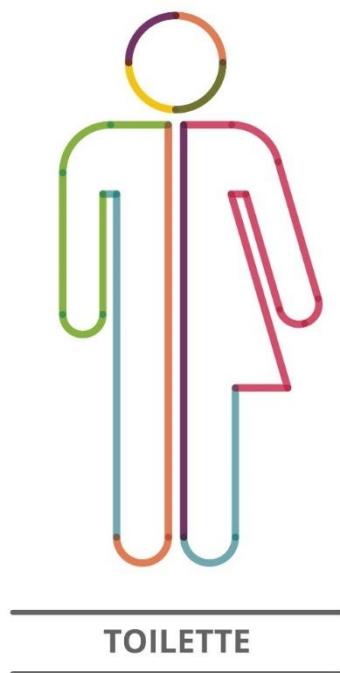


Figure 4S. Toilet panel.

1.2. Informative panels (Compostable materials panel, Greenhouse Info panel, Fountain panel, Garden panels, Aquaponics Aquarium panel, and Wall panel).



Figure 5S. Compostable materials panel.



Figure 6S. Greenhouse info panel.



Figure 7S. Fountain panel.



Figure 8S. Garden panel.

2. Questionnaires - Italian language version

2.1. Santa Barbara Sense of Direction Scale

1. Sono molto bravo/a a dare indicazioni.
2. Non ricordo bene dove ho lasciato le cose.
3. Sono molto bravo/a a giudicare le distanze.
4. Il mio "senso dell'orientamento" è molto buono.
5. Tendo a pensare al mio ambiente in termini di direzioni cardinali (N, S, O, E).
6. Mi perdo molto facilmente in una nuova città.
7. Mi piace leggere le mappe.
8. Ho problemi a capire le indicazioni.
9. Sono molto bravo a leggere le mappe.
10. Non ricordo molto bene i percorsi da fare in auto come passeggero.
11. Non mi piace dare indicazioni.
12. Per me non è importante sapere dove mi trovo.
13. Di solito lascio che qualcun altro si occupi della pianificazione del percorso per viaggi lunghi.
14. Di solito riesco a ricordare un nuovo percorso dopo averlo fatto una sola volta.
15. Non ho un'ottima "mappa mentale" del mio ambiente.

Responses of a 7 points Likert scale: 1- “fortemente d’accordo”, 7- “per nulla d’accordo”.

2.2. Internal company survey

1. Quale è l’indicazione che dai più spesso al pubblico delle serre? (una o più indicazioni, quelle che ti vengono in mente).
2. Quale è il comportamento che ti fa più incazzare del pubblico delle serre? (o cose che non vorresti che facessero).
3. Ci dici una cosa che ti piacerebbe che il pubblico delle Serre sapesse o capisse, rispetto a tutto l’ecosistema Kilowatt/Serre/Serra Madre? (anche più di una, se ne hai).
4. C'è qualche suggerimento generale che vuoi dare a chi progetterà la nuova segnaletica?

2.3.Landmarks evaluations

For *Direction panels*:

- a) Hai notato questo Landmark?
- b) Hai utilizzato questo landmark per orientarti?
- c) Quanto ti ha aiutato?

- d) Quanto è stato utile per il tuo orientamento all'interno delle Serre?
- e) Quanto ti affideresti a questo landmark per dare indicazioni a qualcun altro/a?
- f) Sapresti dire dove l'hai visto? (Risposta aperta)

Responses on 5 points Likert scale 1-5: 1- “per niente”, 5 – “moltissimo” (except open question “f”)

For *informative panels*:

- g) Hai notato questo Landmark?
- h) Quanto ti affideresti a questo landmark per dare indicazioni a qualcun altro/a?
- i) Hai letto il suo contenuto durante in giro nelle Serre?
- j) Sapresti dire dove l'hai visto? (Risposta aperta)

Responses on 5 points Likert scale 1-5: 1- “per niente”, 5 – “moltissimo” (except for question “f”).

Open questions:

- k) Quali informazioni hai appreso in generale sulle Serre e sulle sue attività? Scrivi tutto ciò che ricordi.
- l) Ricordi informazioni sull'orto? Se sì, scrivi quali.
- m) Ricordi informazioni sul giardino? Se sì, scrivi quali.
- n) Ricordi informazioni sull'acqua potabile? Se sì, scrivi quali.
- o) Ricordi le informazioni sulla raccolta differenziata? Se sì, scrivi quali.

2.4. Familiarity with the place

1. Sei mai stato/a alle Serre prima d'ora? Se sì, quante volte sei stato alle Serre?
2. Quanto ti è familiare questo posto?

Responses to question 2 given on a 7 point Likert scale: 1- “per niente”, 5 – “moltissimo”

D) Study 5 – Aesthetic Experience and Descriptive Information in the Art of Re-purposing

1. Complete list of Artworks

1.1. DWd and DWnd conditions

1. Alejandro Duran, Algas (Algae), 2013, Washed up photo series
2. Alejandro Duran, Amanecer (Dawn), 2011, Washed up photo series
3. Alejandro Duran, Riachuelo (Brook), 2017, Washed up photo series
4. Alejandro Duran, Rayo (Ray), 2018, Washed up photo series
5. Alejandro Duran, Gota (Drop), 2011, Washed up photo series
6. Alejandro Duran, Mar (Sea), 2013, Washed up photo series
7. Alejandro Duran, Nubes (Clouds), 2011, Washed up photo series
8. Alejandro Duran, Vena (Vein), 2011, Washed up photo series
9. Benjamin Von Wong, Final 3 (modified) 2018, Truck load of plastic
10. Benjamin Von Wong, Final 2, 2019, Plastikophobia,
11. Benjamin Von Wong, Final 4 (modified), 2018, Truck load of plastic
12. Benjamin Von Wong, Plastic Beach (Final 4), 2021, Turn off the Plastic Tap
13. Benjamin Von Wong, Plastic Playground (Final 2), 2021, Turn off the Plastic Tap
14. Benjamin Von Wong, Plastic Mermaid 2 (Plastic Beach), 2016, Mermaid plastic
15. Benjamin VonWong, Dell E-Waste Awareness 2, 2017, Rethink Recycle Retrieve
16. Benjamin VonWong, Mermaid Swims in 10,000 Plastic Bottles, 2016, Mermaid plastic

Rethink Recycle Retrieve project: <http://www.RethinkRecycleRevive.com>

Original source for number 15:

https://www.dropbox.com/scl/fo/ctmztp9nvnuql10kn6z0/AJiliZbJqkUiJKyIUjC_So/Her o%20Shots?dl=0&preview=VonWong_Dell_E-Waste_Awareness-2.jpg&rlkey=dtwxb5l2t771hdjmhpbp36sc1&subfolder_nav_tracking=1

All the other original sources are already listed in Appendix B (§2.).

1.2. PSd and PSnd conditions

1. Jane Perkins, The Kiss, after Klimt, 80cm x 80cm, 2019
2. Jane Perkins, Girl with a Pearl Earring, after Vermeer, 74cm x 69cm, 2011
3. Jane Perkins, Japanese Bridge, after Monet, 80cm x 80cm, 2011
4. Jane Perkins, Mona Lisa, after Da Vinci, 79cm x 71cm, 2011
5. Jane Perkins, Marilyn, after Warhol, 60cm x 60cm, 2015
6. Jane Perkins, Three Sunflowers, after Van Gogh, 73cm x 58cm, 2012
7. Jane Perkins, Madonna and Child, after Sassoferrato, 80cm x 80cm, 2017
8. Jane Perkins, The Starry Night, after Van Gogh, 83cm x 65cm, 2018
9. Annarita Serra, Connection, Schede madri PC, 90×90 cm, 2020-21
10. Annarita Serra, Digital Heart, Schede madri, 70×70 cm, 2022-23
11. Annarita Serra, La libertà è partecipazione, Plastica dal Mare, 100×100 cm, 2020-11
12. Annarita Serra, Message in a bottle, Plastica dal mare, 90×90 cm, 2018-19
13. Annarita Serra, Montevécchio, Plastica dal Mare, 20×20 cm, 2006-07
14. Annarita Serra, Second life, Schede madri PC, 90×90 cm, 2020-21
15. Annarita Serra, Urlo, Plastica dal mare, 90×90 cm, 2018-19
16. Annarita Serra, Zio Tom, Plastica dal Mare, 40×40 cm, 2006-07

Original source links:

<https://janeperkins.co.uk/plastic-classics/>

<https://annaritaserra.com/artworks/>

2. Descriptive information

Jane Perkins:

Mentre lavorava alla sua tesi di laurea sull'arte fatta da materiali riciclati, questa artista scoprì alcune immagini di copricapi religiosi dell'Ecuador, decorati con una folle miscela di oggetti trovati a caso (lampadine, monete, bambole, ecc.) e furono d'ispirazione per il suo primo progetto: una collezione di spille cucite a mano, impreziosite da una varietà di piccoli oggetti trovati. Mentre realizzava le spille, raccolse un sacco di materiali che erano troppo grandi per essere usati: iniziò così a comporre dei ritratti e a ricreare le opere di artisti famosi.

Queste opere sono create utilizzando qualsiasi materiale che abbia la giusta dimensione, forma e colore: giocattoli, conchiglie, bottoni, posate di plastica, perline, gioielli rotti, ecc. Non viene aggiunto alcun colore, tutto viene usato così come viene trovato. I dipinti impressionisti sono di particolare ispirazione per le sue opere, osservabili in due modi: da lontano per dare un senso all'intera immagine, e da vicino per identificare le pennellate (ovvero i materiali).

Annarita Serra:

Questa artista, per realizzare i suoi lavori, usa oggetti di scarto sapientemente ricomposti. Alcuni dei suoi lavori sono realizzati con la plastica che ha raccolto sulle spiagge della Sardegna, volendo porre così l'attenzione sull'annoso problema della plastica che inquina i mari. Gli oggetti ritrovati ed i materiali di scarto vengono usati come se fossero vere e proprie pennellate, ma senza utilizzare nessun pennello e nessun colore, bensì colla, chiodi e trapani. Altre opere sono state create riutilizzando le componenti di vecchi computer destinati al macero, un modo per trovare una nuova funzione a tutti quei rifiuti tecnologici che la società di oggi produce in massa e che troppo spesso non vengono riciclati. Le sue opere creano l'effetto di un'immagine riconoscibile che attira l'attenzione, ma solo avvicinandosi si scopre il materiale di cui sono composte, immondizia ed oggetti di scarto che fanno da testimoni del silenzioso grido d'aiuto di una natura sempre più contaminata.

Alejandro Duran:

Questo artista nel 2010 ha iniziato a raccogliere tutta la plastica che trovava a riva lungo la costa di Sian Ka'an, una delle più grandi riserve naturali protette del Messico e patrimonio mondiale dell'UNESCO, identificando rifiuti di plastica colorata provenienti da cinquantotto nazioni e da territori di sei continenti diversi. L'artista allora iniziò ad utilizzare questi detriti per creare sculture a base di colori, delle opere in cui la mano dell'uomo si confonde con quella della natura. La spazzatura non viene dipinta, ma raccolta e organizzata per colore. A volte distribuisce gli oggetti come farebbero le onde; altre volte la plastica imita alghe, radici, fiumi o frutti, riflettendo l'infiltrazione della plastica nell'ambiente naturale. La serie di foto che ne risulta ritrae una nuova forma di colonizzazione da parte del consumismo, in cui anche

i terreni non sviluppati non sono al sicuro dall'impatto di vasta portata del nostro stile di vita usa e getta.

Benjamin Von Wong:

Questo artista è un'attivista noto soprattutto per le sue installazioni d'arte ambientale e per il suo stile iperrealista. Ha prodotto diverse campagne di sensibilizzazione creando installazioni con i rifiuti di plastica: per alcune delle sue opere ha progettato il riuso di 168.000 cannucce, 18.000 bicchieri, e 10.000 bottiglie, coinvolgendo le popolazioni locali e provando a rendere più interessante il noioso problema dell'inquinamento e della produzione della plastica. Negli anni ha concentrato la sua attenzione sulla costruzione di comunità intorno alle sue installazioni, come per il suo progetto più famoso che ha dato lavoro temporaneo ad oltre 100 residenti delle baraccopoli di Kibera in Africa.

L'incontrollabile uso dei bicchieri usa e getta, la plastica che viene riversata in mare, e le tonnellate di rifiuti plastici non riciclabili e contaminati che vengono esportati ogni anno nei Paesi più poveri, sono alcuni dei temi che hanno ispirato i progetti, degli storytelling che mirano ad agire piuttosto che ad essere semplicemente spettatori.

3. Variables

Complete list of items in Italian language.

3.1. Beauty

1. " Quanto pensi che sia bella l'immagine?".

Per niente – estremamente

3.2. Emotions

1. In che misura questa esperienza ti ha suscitato ciascuno di questi sentimenti?

[7 Positive: Felicità, Speranza, Stupore, Sorpresa, Ispirazione, Entusiasmo]

[7 Negative: Colpa, Tristezza, Delusione, Impotenza, Rabbia, Ansia, Vergogna]

Per niente – estremamente

3.3. Meaningfulness

1. Quanto hai compreso il contenuto di questa immagine? [NO]
2. Quanto è rilevante questa immagine per te personalmente?
3. Quanto pensi che quest'immagine sia rilevante per la società?

Per niente – estremamente

3.4. Cognitive Reflection

1. Queste opere sembrano rilevanti per la mia vita quotidiana.
2. Queste opere evidenziano conseguenze che mi riguardano personalmente.
3. Queste opere mi fanno riflettere sul mio ruolo nella comunità.
4. Queste opere mi rendono più consapevole del mio impatto comportamentale sull'ambiente.

fortemente in disaccordo - fortemente d'accordo

3.5. Monetary estimation

1. Qual è il valore monetario che attribuiresti a quest'opera?

1€-1000€

3.6. Intentions to change behavior (ICB)

In futuro, cercherò più spesso di:

1. riparare gli oggetti danneggiati.
2. comprare cose usate.
3. comprare meno in generale.
4. comprare meno prodotti non durevoli e più prodotti di alta qualità con una durata maggiore.
5. non prendere l'aereo in vacanza, ma rimanere nella regione.
6. acquistare capi di abbigliamento provenienti da una produzione equa e sostenibile (con certificato)

fortemente in disaccordo - fortemente d'accordo

3.7. Intentions for Pro-Environmental Behavior (IPEB)

In che misura sei disposto/a ad adottare i seguenti comportamenti nei prossimi mesi:

- 1) Conservare le risorse e l'energia.
- 2) Riciclare i materiali (ad esempio vetro, plastica, carta).
- 3) Differenziare i rifiuti.
- 4) Utilizzare sacchetti multiuso (non di plastica) per la spesa.
- 5) Ricordare agli altri di evitare comportamenti dannosi per l'ambiente.
- 6) Cercare informazioni ambientali in TV, sulla carta stampata o su Internet.
- 7) Donare denaro per sostenere la conservazione dell'ambiente.
- 8) Fare volontariato per progetti a favore dell'ambiente.

per nulla probabile – molto probabile

3.8. Ecological worldview - NEP

1. Stiamo raggiungendo il limite massimo del numero di persone su questa Terra
2. Gli esseri umani hanno il diritto di modificare l'ambiente naturale per i propri bisogni
3. Quando gli esseri umani interferiscono con la natura, si producono effetti disastrosi.
4. Grazie all'ingegno umano, la Terra rimarrà un luogo vivibile
5. Gli esseri umani stanno abusando gravemente dell'ambiente
6. La Terra in realtà ha tante risorse naturali se solo sapessimo farne buon uso
7. Gli esseri umani hanno il dovere di tutelare la vita di animali e piante
8. L'equilibrio dell'ambiente è forte abbastanza da reggere l'impatto della società industrializzate.
9. Malgrado i progressi, siamo ancora in balia della forza della natura
10. I problemi ambientali sono stati in larga misura esagerati
11. La terra ha risorse limitate
12. Gli esseri umani sono destinati a comandare sulla natura

13. L'equilibrio della natura è delicato e fragile
14. Con il tempo gli esseri umani impareranno come funziona la natura e riusciranno a controllarla
15. Se le cose vanno avanti così, presto ci sarà una catastrofe ambientale.
- fortemente in disaccordo - fortemente d'accordo

3.9. Perceived Behavioral Control

1. Per me, comportarmi in modo sostenibile è in generale:
completamente impossibile - molto possibile.
2. Per me, comportarmi in modo sostenibile è finanziariamente:
completamente impossibile - molto possibile.
3. Per me raggiungere uno stile di vita sostenibile è:
molto difficile - molto facile.
4. Se lo volessi, sarebbe facile per me comportarmi in modo sostenibile:
molto improbabile - molto probabile.
5. La decisione di comportarmi in modo sostenibile è sotto il mio completo controllo:
per niente - completamente
6. Per me le strutture di riciclaggio sono:
non facilmente disponibili - facilmente disponibili